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THE GROWTH OF JELLY-FISHES.

A CHAPTER IN THE NEW ZOÖLOGY.

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I.

ON any landlocked and sheltered sea-beach, where the waves ripple up on to the sand without breaking, hundreds of small spiral sea-shells may usually be found in the shallows dancing up and down the sand at the water's edge, following the crest of each little wave as it flows up and spreads out over the beach, and turning to run back with it as it falls; keeping always just within the water, and exhibiting restless activity and agility, quite unlike the sluggish habit of the snails which normally inhabit the shells.

If the loiterer by the waves should be inquisitive enough to be attracted by them, and should search for the meaning of the unusual liveliness of the snails, he would find that each shell is inhabited by a hermit-crab, that, after devouring the true owner of the house, has thrust his own body into it, and carries it about, as a defense against his many enemies, among whom his pugnacious and cannibal brothers and sisters are perhaps the worst.

So much the most superficial observer may discover for himself; but if, with a naturalist's sharp sight and thirst for knowledge, he examine more closely, he will find that about one in a dozen of the shells is coated, upon the surface which is uppermost as the crab carries it, by a white crust of a mossy substance which is not found upon the empty shells which lie on the bottom, nor upon the shells of living snails. If, impressed by this odd fact, he detach a little of the moss and examine it under a microscope, in a watch-glass filled with sea-water, he will find that it is

a most remarkable and interesting community of minute animals, a polymorphic hydroid colony, well worth most exhaustive investigation. Several species and genera of hydroids are found upon the shells of hermit-crabs, but they are usually pretty much alike in general organization; and our Fig. 1, which is a highly magnified drawing of a small portion of a colony of the hydroid larvæ of *Dysmorphosa*, will serve to represent their character.

The crust on the surface of the shell consists of a network of tubes, cemented to the shell and to each other in a mass from

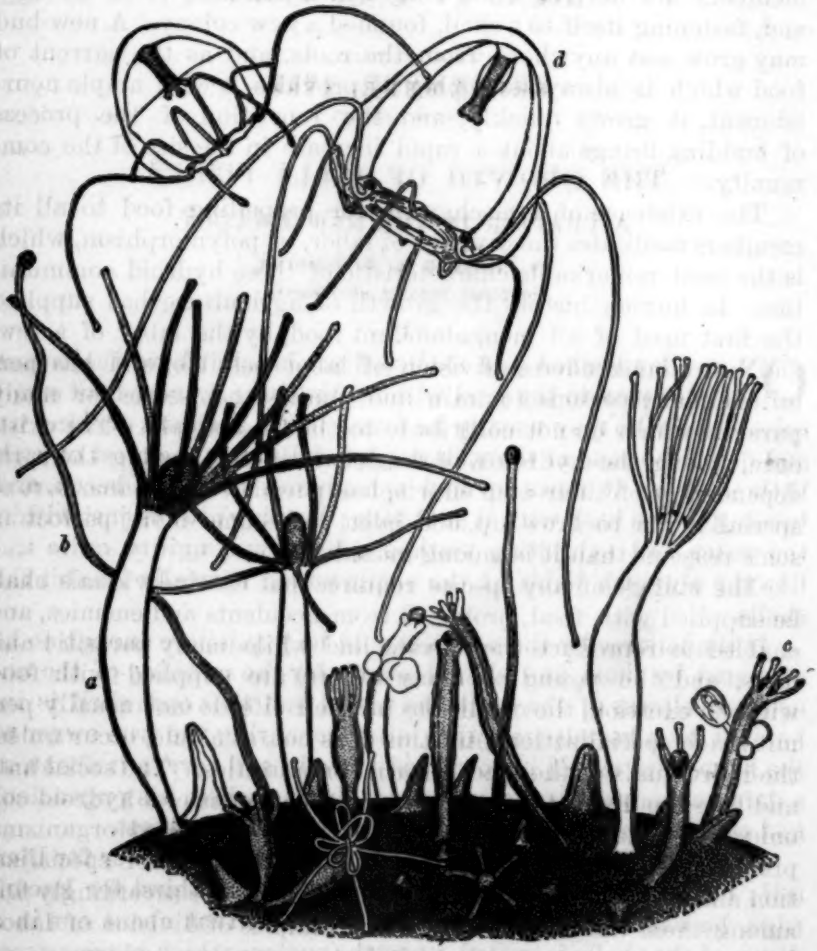


FIG. 1.

which the bodies of the individual hydras protrude, somewhat as the stem of a tree rises erect from the creeping root, although the community is more like a thicket of suckers than a single tree, for all its members spring from one system of roots, and, although

they may be numbered by hundreds or even thousands, form one continuous organism.

The stomach of each member of the colony is directly continuous with the hollow roots, and, through these, with the body of every other member, and any food which is captured and digested by one, serves to nourish all, since it circulates everywhere through the roots, as water flows through the mains to all the houses in a city.

The whole is the result of multiplication by buds, and all the members are derived from one, which hatched from an egg, and, fastening itself to a shell, founded a new colony. A new bud may grow out anywhere, from the roots, and as the current of food which is always sweeping by provides it with ample nourishment, it grows quickly, and the repetition of the process of budding brings about a rapid increase in the size of the community.

The existence of a mechanism for propelling food to all its members facilitates the division of labor, or polymorphism, which is the most remarkable characteristic of these hydroid communities. In human history the growth of agriculture has supplied the first need of all men, abundant food, by the labor of a few, and has thus rendered division of labor possible, and has permitted many persons to train and qualify themselves for many pursuits which do not contribute to the food-supply. The existence, among the hydroids, of a mechanism for feeding them independently of their own efforts, has permitted the same sort of specialization to grow up, and even to become more perfect in some respects than it is among mankind.

The welfare of any species requires that the individuals shall be supplied with food, protected from accidents and enemies, and enabled to reproduce the species, and while many parasitic animals, and the young of many others, are supplied with food without exertion, the conditions of their life do not usually permit much specialization, and this does not, as a rule, occur unless the individuals of the species form communities. The social ants and bees are divided into castes, and the existence of hydroid colonies, which are structurally united into compound organisms, presents the conditions which are most favorable for specialization among the members of the community. We accordingly find among them the most remarkable examples of division of labor, accompanied by structural specialization or polymorphism.

A young dysmorphosa colony consists of a creeping root, which carries a number of hydras, all of them like *a* in the figure. They are the eating and digesting members of the society. Each of them has a long tubular body, almost completely filled by a capacious stomach, which opens to the exterior, at the free end of

the body, through a mouth which is mounted upon a short, flexible proboscis, and is surrounded by a circlet or crown of long, elastic tentacles, radiating out in all directions around the mouth, and fringed by a poisoning apparatus of microscopic darts, which kill all the small animals which venture within the sweep of the tentacles. The food that is thus captured is conveyed to the mouth, and is swallowed and digested.

As the colony grows and the feeding members become numerous enough to store up a stock of nutriment and to bear the burden of a few non-productive parasites, hydras like *b* in the figure are produced. They are the fighting members, and have neither mouths nor stomachs, but each consists of an enormously elongated body, which ends in a battery of poison-darts, which is comparable to a circlet of undeveloped tentacles. The entire body of one of these fighting hydras is practically equivalent to a single enormous tentacle, although comparative anatomy shows clearly that it is not a tentacle, but that it corresponds to the whole body of a feeding hydra, tentacles and all, rather than to a single tentacle; that it is actually a hydra which has, during the evolution of the species, lost its mouth and stomach, and its power to capture and swallow food, and has become specialized for defense. These long, slender, outstretched bodies project far beyond the other members of the colony, and their poison-batteries wave in all directions over the heads of the feeding hydras. The shock of contact with them is either fatal or violent enough to paralyze any intruder, or to cause it to beat a hasty retreat.

As the community gains in numbers and strength, buds of a third sort are produced from the root, and become the reproductive hydras or *blastostyles*, which are shown at *c* in the figure. They are much like the feeding hydras in shape and in general structure, but the tentacles remain rudimentary throughout their life; they have no mouths, and their capacious stomachs do not open to the outer world, although their walls vigorously assimilate the food which flows into them through the roots.

As soon as the blastostyle is fully grown, a circlet of buds grows out from its body, just below its rudimentary tentacles. These buds soon acquire an organization which is very different from that of any of the forms which have been described, and, developing organs of locomotion, are ultimately detached from the blastostyles, and are set free to begin their independent life as solitary, swimming jelly-fish, like those which are shown at *d* in the figure.

The active jelly-fish is as different from all the members of the hydroid colony as a butterfly is from a caterpillar. When fully grown it is vastly larger than a hydra, and it has a well-developed swimming apparatus, which is under the control of a

nervous system, which again is brought into relation with the external world by means of special sense-organs. It is a gelatinous bell, from the inner surface of which the pendent stomach hangs down like the bell-clapper, while the long, graceful, thread-like tentacles are attached at regular intervals around the opening of

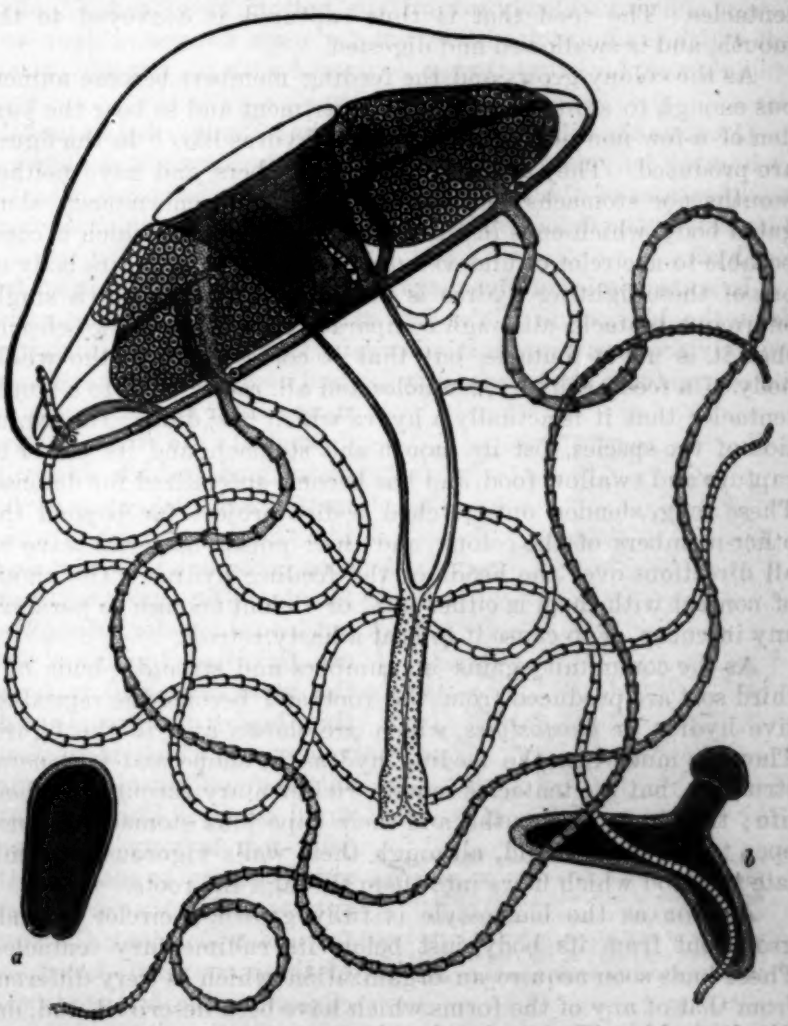


FIG. 2.—*Liriope scutigera*, slightly magnified, drawn from Nature by W. K. Brooks. (The small figure in the left-hand lower corner is the planula of Turritopsis, greatly magnified; and the one in the right-hand corner, the root and the first bud of the Turritopsis hydroid.)

the bell. The locomotor muscles are so distributed over the inner surface of the bell that their contraction squirts out the water in a jet which propels the animal in the opposite direction; they are then relaxed, and the elasticity of the gelatinous substance of the wall of the bell causes it to expand and to draw in another supply

of water which is discharged by the next muscular pulsation. The tentacles are so elastic and hair-like that they are held by the resistance of the water, and are drawn out behind the animal into fine glassy threads which are thrown into graceful undulations at each pulsation as it swims through the water, and, when it comes to rest and sinks slowly toward the bottom, they form a web or net which is almost invisible, but far more dangerous than any spider's web, for every thread is covered with the terrible poison-darts.

Great as the difference is between the sedentary hydra and the swimming jelly-fish, comparative anatomy shows that they are modifications of the same type, and that the jelly-fish, like the blastostyle, the defensive hydra and the root, is a specialized feeding hydra.

In some species of Dysmorphosa the jelly-fish which is set free from the blastostyle is the last stage in the long series, and it quickly acquires reproductive organs, lays its egg or discharges its spermatozoa as the case may be, and dies; but in other species it no sooner begins its own independent life than it produces buds which are ultimately set free, as jelly-fish like the parent, each of which soon becomes a mature male or female. The eggs are thrown out into the water, where they are fertilized by union with the male cells, and each egg then begins the process of development, which is to result in the founding of a new hydroid colony. The life of the jelly-fish is very short, and simply serves to multiply the species, and to scatter the eggs far and wide along the shore of the ocean, and thus to secure the wide distribution of the hydroids. The egg hatches, however, neither into a jelly-fish like the parent, nor into a hydra, but into a minute microscopic animal of extremely simple structure, which is known as a *planula*. Fig. 2, *a*, which is a highly magnified drawing of the planula of another species, will serve to show what it is like. It has no mouth nor tentacles, and its pear-shaped body is covered with cilia, by means of which it swims slowly through the water for a short time, but, unless its slight locomotor power soon brings it into

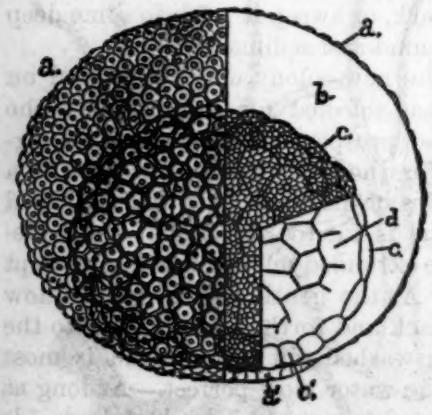


FIG. 2.—Planula of *Liriope scutigera*, highly magnified, drawn from Nature by W. K. Brooks: *a*, surface layer of cells, which is shown in section on the right half; *b*, gelatinous substance; *c*, inner layer of cells, shown in section in the lower right-hand quadrant; *d*, the central cavity; *a'*, the point where the mouth is to be formed.

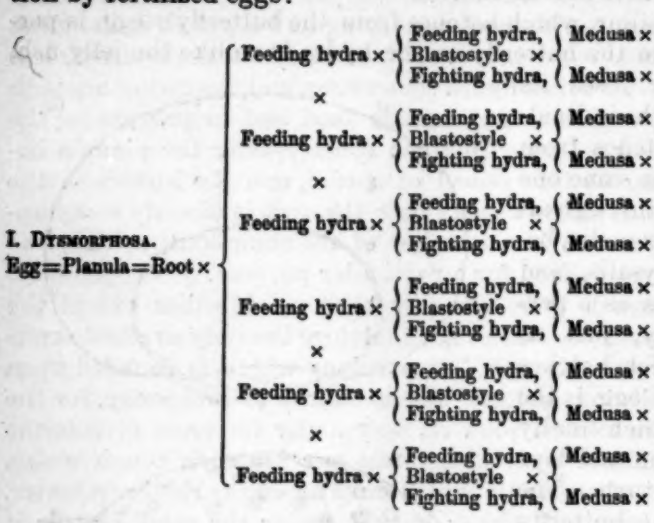
contact with some solid body upon the bed of the ocean, it dies. With the discovery of a solid resting-place its purpose is accomplished: it loses its cilia, and, cementing its body fast, it elongates and becomes converted into a root, from which the bud which is to form the first feeding hydra soon arises, and, acquiring a mouth and tentacles, begins to accumulate food and to provide for the growth of a new colony. In some other species the planula becomes a feeding hydra instead of a root, and the history of the various hydroids shows clearly that the root is directly comparable with a hydra and is a member of the community which, like the others, is specialized for a particular purpose.

On a sea-beach there are few hard solid bodies except the shells of mollusks, and these are therefore the only available resting-places for the planulæ, but a colony which is founded upon the shell of a living mollusk has no chance of prosperity, for the mollusk is sure to soon plow its way under the sand or into the mud, and a delicate hydroid can not survive such rough usage, nor is the case of a planula which finds an empty shell any better, for the first storm will either bury it under the sand, or toss it high and dry above low-tide mark, or sweep it off into some deep channel to be buried under the mud and sediment.

Everything is favorable to the new colony which is started on a shell which a hermit-crab has selected for a house, and the chances are that it will grow and prosper and soon become a vigorous, flourishing settlement; for the crab does not creep like a snail, but trots around on the tips of his claws with the shell held well up above the sand, and he is far too intelligent and wide-awake to permit himself to be stranded on the beach, or swept away into muddy quicksands. As the gentle waves ebb and flow on the shore he follows them back and forth, keeping close to the edge, where the food which is washed out of the sand is most abundant and the aëration of the water most perfect. As long as the sea is calm he may be trusted to carry his load of hydroids into the places which are most favorable for them, and as soon as a storm approaches he trots off with his charge to a safe shelter in deeper water and waits until it has passed. A colony which is founded on his shell is sure to flourish and increase, for this location affords all the elements of prosperity, and, while small colonies are often found in other places, the most vigorous and largest ones are, as a rule, found only in this peculiar habitat.

In the following diagram I have attempted to exhibit at one view all the phases in the remarkable life-history of Dysmorphosa. The sign of equality = between two stages indicates that the one on the left becomes transformed into the one on the right, without multiplication and without loss of identity; the sign × indicates

asexual multiplication by buds, and the sign < sexual reproduction by fertilized eggs:



The egg hatches into a planula, which becomes attached and is *converted* into a root, from which feeding hydras *bud;* from the roots of these feeding hydras, other feeding hydras, and, after a time, defensive hydras and blastostyles or reproductive hydras, are budded in very great numbers, and, while the diagram correctly represents the complexity of the colony, it conveys no conception of its size or of the number of its members. Each blastostyle produces a considerable number of buds, which are ultimately set free as swimming jelly-fish or Medusæ, and each medusa multiplies by budding, and thus gives rise to a second generation of Medusæ, which probably repeat the process in their turn, so that a very great and practically unlimited number of sexual egg-producing adults results from a single egg.

What a contrast between the direct and simple history of ordinary animals, where each adult is the total progeny of the egg, and such a life-history as this, where the egg not only produces an unlimited number of sexual adults able to bud off others like themselves, but also gives rise to an innumerable number of larvæ which never become sexually mature nor assume the adult form.

Those who are familiar with the subject know how much paper and ink have been wasted in discussing the individuality of hydroids, but we need not enter into into this dead issue, for, beyond question, each feeding hydra, each defensive hydra, each blastostyle, and each jelly-fish is an individual in the same sense that a horse or a dog is one; and the most remarkable peculiarity of Dysmorphosa is the enormously great number of descendants from each egg. Another peculiarity must also be noted. The life-his-

tory is not a simple process of growth, nor a metamorphosis, like that which occurs among insects.

The caterpillar, which hatches from the butterfly's egg, is perhaps as unlike the butterfly as the hydra is unlike the jelly-fish, but it never loses its identity, and the individual which hatches from the egg is the same one which passes through all the caterpillar molts, becomes a chrysalis, and finally escapes as a perfect butterfly, just as the chick which hatches from a hen's egg is the individual which finally becomes a hen and lays eggs in her turn. The growth of the butterfly is accompanied by great and sudden changes from one stage of development to another, but it is simply a process of growth and development, while the life of Dysmorphosa is quite different. The planula, which hatches from the egg, becomes metamorphosed into a root, just as the caterpillar becomes changed into a chrysalis; but here the resemblance stops, for the root goes no further, and it may still remain a root after numbers of jelly-fishes have grown up, laid their eggs, founded new colonies, and died. The feeding hydras and defensive hydras never grow up into jelly-fish, but, as long as they live, continue to perform their proper parts in the colony, and this is equally true of the blastostyles, for these do not become jelly-fish; they simply produce jelly-fish buds, and each one may persist as a blastostyle and continue the process of budding long after the younger buds have completed their history.

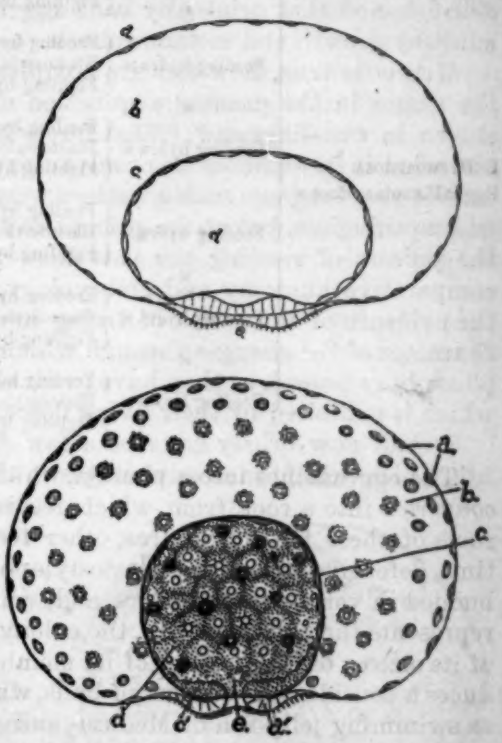


FIG. 4, a section, and Fig. 5, a surface view of the larva of Liriope, to show the formation of the mouth, *c*, and the stomach, *d*.

In all these particulars the life of Dysmorphosa is a great departure from the normal life-history of animals, for, as a rule, each embryo which hatches from an egg is destined to become an adult animal, and only one.

The simpler aspects of the phenomena of life are older or more

primitive than their more complex manifestations, and all analogy forces us to believe that Dysmorphosa is the descendant of some remote ancestor whose life-history was as simple and direct as that of a bird or a mammal or a frog, a butterfly, a snail, a crab, or a star-fish, and that originally each egg became converted into an adult by growth and metamorphosis.

If this is true, how has its complexity arisen? What were the stages in the gradual acquisition of the life-history which is shown in our diagram? What forces have produced the change, and what is its significance or advantage?

Not very long ago such questions were held to be unanswerable and meaningless, but at the present day we are all familiar with the process of reading the past history of life by the study of comparative anatomy and embryology, and are ready to accept the evidence of the series of living hydroids which show us the character of the changes through which the ancestors of Dysmorphosa have passed, as they have gradually acquired the structure which is exhibited by their living descendants.

I shall now briefly describe a few American species of jelly-fish, which exhibit successive stages in the process of complication, and serve to show that the remote ancestor of Dysmorphosa must have been a jelly-fish, which passed, during its development, through a transitory larval hydra stage, which was only a step in the process of growth of the embryo into an adult. In this form each egg produced one animal; the adult life was all-important, and the hydra stage was passed as quickly as possible; and during the history of the species this has gradually become a more and more important part of the whole life, until finally the adult jelly-fish has become comparatively unimportant and simply serves to secure the distribution of the species, while the larvæ have acquired the power to bud and to build up colonies, the members of which have become specialized in various directions, by division of labor, for the benefit of the whole.

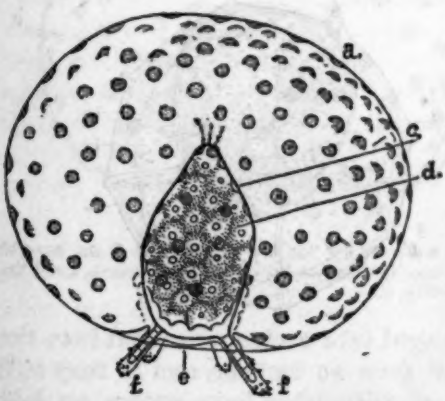


FIG. 6.—Hydra stage of the larva of Liriope: *d*, stomach; *e*, mouth; *f*, tentacles.

One of the most graceful *Medusæ* of our Southern coast, from Florida to the Chesapeake Bay, is the beautiful Liriope shown, somewhat enlarged, in Fig. 2. It is not very different from Dysmorphosa in shape, but it is much larger, and a most active and

elegant creature, with a bell like cut-glass, and long, waving tentacles. Its movements are so instinct with grace that an admirer of the lines and curves of Nature could desire no better or more fascinating occupation than the observation of an aquarium stocked with a few specimens of this attractive jelly-fish. The drawing is accurate, so far as mere shape goes, but no drawing can represent its jewel-like brilliancy or the elegance of its movements. Its chief interest to us, however, centers in its life-history, which is very different from that of Dysmorphosa. Its proper home is the deep water of mid-ocean, not the shallows near shore; and it has no attached stage of development, but floats or swims at all periods of its life. The eggs are thrown out into the water, and each one soon develops into the embryo which is shown, highly magnified, in Fig. 3.

This embryo, which is a planula adapted for floating instead of swimming, is a hollow sphere, the walls of which are formed of

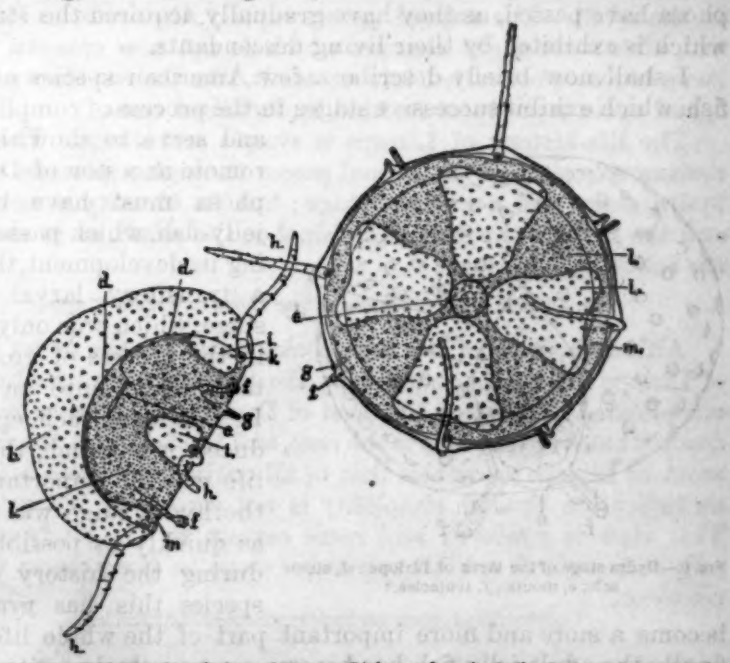


FIG. 7, side view, and Fig. 8, a broad view of a young Liriope: *b*, swim-bell; *d*, stomach; *e*, mouth; *f*, larval tentacles; *g*, long tentacles of adult; *h*, short tentacles of adult; *i*, areas of adhesion; *k*, otocysts; *l*, radial canals.

two spherical shells, an outer one, *a*, which forms the surface of the body, and an inner one, *c*, which lines the central cavity, the two being separated from each other by a gelatinous layer, *b*, which serves to float the embryo in the water. The central cavity has at first no opening to the exterior, and the two shells are concentric, but they soon approach each other at a point, *a'*, and

an opening to the exterior is formed. The central space now becomes the stomach, *d*, in Figs. 4 and 5, and the opening becomes the mouth, *e*, in Figs. 4 and 5. Soon after the mouth is formed a circlet of tentacles is developed around it, and the larva becomes a hydra, but a hydra adapted to a floating life rather than a fixed life, as shown in Fig. 6.

It is now able to capture and digest food and to lead an independent life, and it grows rapidly, although it has as yet no locomotor organs, and drifts at the mercy of the waves.

Soon the stomach becomes flattened and the mouth pushes in toward the center of the sphere, carrying with it the surface layer of cells, and thus giving rise to a concave, hollow bell-cavity opening to the exterior, as shown in Fig. 7, in which *d* is the flattened stomach, *e* the mouth, and *f* the cavity of the swim-ball.

As the mouth is pushed in, the tentacles are left behind and remain on the edge of the bell in the position which they occupy in the adult. The animal grows rapidly, the tentacles lengthen, and, after some slight changes which do not now concern us, the larva becomes converted into an adult, like the one shown in Fig. 2, and again reproduces its kind by fertilized eggs.

The life-history of Liriope is simple and direct. There is a metamorphosis, and the animal passes through a planula stage, a hydra stage, and a medusa stage; but its identity is never lost, and the larva is the same individual as the adult, as is shown in the following diagram:

II. Liriope.—Egg = Planula = free Hydra = Medusa < eggs.

Although most of the text-books state that the direct history of Liriope has been produced by the gradual simplification of a complicated life-history like that of Dysmorphosa, there is no evidence whatever that this is the case, and the fact that the development of Liriope resembles that of all ordinary animals is in itself an indication that its simplicity is not secondary but primitive. This view is rendered still more certain by the study of other jelly-fishes which exhibit successive steps in the process of complication.

Dr. Karl Pettersen, Director of the Tromsö Arctic Museum, has suggested that the object of polar expeditions could be obtained most easily, surely, and cheaply, by dispatching, instead of single sporadic expeditions, every year, for a period of ten or eleven years, a number of well-equipped steamers from certain suitable points toward the pole. Amid the ever-varying shifting of the polar drifts and currents, some of these vessels might possibly get through. He recommends four points of departure for such vessels: one along East Spitzbergen and Franz-Josef Land, and northward; one east of Franz-Josef Land, from the Yenisei or Obi; one by way of Franz-Josef Land, starting from the New Siberian Islands or the Lena; and one from a suitable spot in Bering Strait.

SOME CHINESE MORTUARY CUSTOMS.*

By ADELE M. FIELDE.

WHEN the Chinese wish to declare the extreme vexatiousness of any piece of work, they say, "It is more trouble than a funeral"; the obsequies of a parent being reckoned the most maddening affair in human experience.

Infants are buried summarily, without coffins, and the young are interred with few rites; but the funerals of the aged, of both sexes, are elaborate in proportion to the number of the descendants and to their wealth. When a childless married man dies, his widow may perform all the duties of a son toward him, may remain in his house, and may adopt children to rear as his heirs and as worshipers of the family manes. If his widow purposes marrying again, a young male relative may, with the consent of senior members of the clan, undertake the services expected from a son, and may inherit the estate of the deceased.

When one is about to die, he is removed from his couch to a bench or to a mat on the floor, because of a belief that he who dies in bed will carry the bedstead as a burden into the other world. He is washed in a new pot, in warm water in which a bundle of incense-sticks is merged. After the washing, the pot and the water are thrown away together. He is then arrayed in a full suit of new clothing, that he may appear in hades at his best. He breathes his last in the main room, before the largest door of the house, that the departing soul may easily find its way out into the air. A sheet of spirit-money, brown paper having a patch of gilding on one surface, is laid over the upturned face, because it is said that, if the eyes are left uncovered, the corpse may count the rows of tiles in the roof, and that in such case the family could never build a more spacious domicile.

The sons unbraid their queues, and by this dishevelment indicate the confusion of the household. They also take off their tunics, turn one half sidewise over the other half, and put them on again in such a way as to clothe only a moiety of the body. The left shoulder is made bare if it be the father, and the right shoulder if it be the mother, who has died. Thus the son shows that he is denuded of his usual protection, on the one hand or the other, the left ranking above the right in Chinese etiquette. If he be orphaned, he goes naked to the waist in any weather. He also girds himself with a wadded garment twisted into a rope. This cumbrous girdle expresses the fact that he has been obliged to

* The author writes from her own observations at Swatow, but does not mean to be understood as implying that all the customs described are general throughout the empire.—EDITOR.

hastily brace himself for the arduous labors that have come upon him through bereavement.

Messengers go to inform all the kindred of the demise, and an elderly man, of the same surname as the deceased, dressed in sackcloth and followed by the eldest son, takes a new earthen saucepan, goes to a running stream, throws three sheets of spirit-money upon it, and, dipping in the direction of the current, takes water with which to cleanse the corpse. A sprig of bamboo or of banyan is inserted in the snout of the saucepan, the bamboo with its straight, evenly jointed stem being the type of paternal rule, and the banyan, with its unfading verdure, being the symbol of maternal affection. While the son is gone to buy the water of purification, the relatives assemble in the house, and, when his return is announced by his moans, they burst out simultaneously into a loud wail, each naming the relationship of the deceased to himself. It is thought that the son may be comforted by this indirect reminder that his parent had many friends who share the grief of the nearest of kin. The corpse is sprinkled with the water shaken from a branch of pomegranate, the many-seeded emblem of increase, and it is then ready for encoffining. Two paper images, one of a man, the other of a maid-servant, are bought and placed beside the body. A son puts some boiled rice in the mouth of the corpse, saying, "You fed me while I grew, I feed you when you are dead," and then commands the two images to obey the behests of the departed and to run on all errands as directed by him. The images stand rigid before any number of prostrations made by the mourners, but are blown down by a breath of wind. They perhaps inspire the general feeling of superstitious aversion against being fanned by another, and originate the common polite inhibition, "I would receive a hundred obeisances from you sooner than one puff of air from your fan."

The male relatives then go in a body to the temple of the local tutelary deity, and announce the death. They carry lighted lanterns, because the daytime of men is the night of gods and spirits. The bell is tolled, the eldest son prostrates himself before the shrine as many times as will correctly indicate the years of the departed, and gives the sad information of his decease. They then return to the house of mourning, and some one goes to a soothsayer to ascertain what time will be lucky for the encoffining of the corpse. The natal dates, recorded for every member of the family, must be laid before the soothsayer, and some moment must be chosen whose signs are geomantically in accord with those of the birthdays and hours of the living, else evil will accrue to any whose horoscope conflicts. To lay the dead in the coffin without regard to the birth-times of those who assist would endanger life needlessly. Some propitious hour during the first, second, or third

day is usually discovered and fixed upon. This time having arrived, the clothes of the deceased, or new cloth cut into lengths sufficient for a tunic, are distributed among the assistants, are used as girdles while the body is lifted into the coffin, and are afterward kept by the wearers.

Thrifty, elderly persons have stanch coffins made for themselves while in good health. They are kept in a loft, receive a new coat of lacquer occasionally, and harden during perhaps a score of years for final use. If the coffin has not been previously prepared, a son buys one from a maker, who gives the buyer a couple of oranges or a package of confectionery, that the transfer of goods may not be an unmixed sadness to his customer. Some person, familiar with the route, must guide the bearers by the shortest road to the house of the purchaser, for an empty coffin imperils the welfare of the inmates of any dwelling to which it is taken, and a mistake in regard to its destination would bring rough treatment to those who carried it.

After the body is laid in the coffin, a piece of silver, real or counterfeit, is placed under the tongue. It is said that in ancient times the full value of a man's possessions was paid to him by his heirs at his demise, and was deposited with him in his coffin for burial. But later on, though long ago, a man who had foreknowledge, warned his children that there would be a rebellion in their day, and that a certain noble would rifle graves to get funds for the carrying out of his treasonable designs. When this man died, the prospective rebel was invited to assist in encoffining the corpse, and the sons put into the coffin only a small piece of silver, which they slipped under his tongue. Years passed, and the prophecy of the dead father was fulfilled; but, while other graves were opened, his remained undisturbed, because the rebel chieftain knew it contained no treasure. Since that time the practice of putting a bit of silver under the tongue has superseded the older custom of burying large sums of money with the corpse.

The evening after the encoffining a supper is spread for all the relatives of other surname than that of the deceased. Those of the same surname, reckoning themselves sinners, and therefore in sorrow, cook and serve the banquet.

As soon as the corpse is encoffined, a screen of white cloth is stretched across the main room just in front of the shelf on which sit the household gods, opposite the front entrance to the house. The coffin stands parallel with the screen, and close behind it, shut off from the view of those who pass the open door. In front of the screen, at its center, a chair is placed, holding an effigy of the deceased, and dressed in his clothing. This is called the seat of the spirit. Before the effigy a square table is set as an altar, and draped with a white cover and valance. A pair of large bou-

quets of white artificial flowers, stuck in balls of clay, are set upon the altar, and the worship of the dead then commences. Many female relatives stay behind the screen to wail. A child is appointed to watch and give notice of the approach of a worshiper, and at his signal the women wail in chorus. A male relative goes out, receives the guest, and kneels beside him while he bows and touches his forehead to the ground. The guest is then invited into another room to partake of tea, and the wailing ceases until another visitor arrives. Friends of various surnames and clans come during the first six days to pay obeisance to the dead, and bring bundles of spirit-money to be burned before the altar. The son of the recipient of these posthumous honors returns to each a present of a few feet of home-made white cloth, and invites all to the great performances of the seventh day.

The effigy and altar remain a hundred days, and before them the near relatives bow down and weep twice a day. Those who can wail in verse, eulogizing the departed, gain much approbation. Every morning and evening, so long as the coffin is in the house, or for one hundred days if the burial should be longer delayed, a daughter-in-law puts upon the altar a meal of vegetable food. The deceased is supposed to partake of its essence, and it is afterward added to the family mess. Beside the fare set forth for the dead man, there is laid upon the table a single chopstick and an egg for the jailer that has charge of the spirit until it is judged in hades. Having but half a pair of chopsticks to use, he must needs eat slowly, and so the dead man may get his share of the viands set forth!

Besides the occupations already described, the men of the afflicted family must procure food-stuffs, including pork, geese, and ducks, for the entertainment of guests; must hire mourning garments, or buy cloth for making them; must put an awning over the court in front of the house, to enlarge the space wherein the priests are to perform the ceremonies of the seventh day; and must order at the shops where outfits for ghosts are made all the paper paraphernalia which is to be burned at the funeral.

The women must, meanwhile, cook abundant meals for all who assist in the obsequies; must pound bushels of rice into flour for making steamed cakes to offer, with tea, to all comers; must make many little white bags, and put into each two long rolls of raw cotton, some green peas, some unhusked rice, and two copper coins, and must fasten these bags upon cords, whereby they can be tied around the waist. On the seventh day each son and son's wife wears three of these bags, all the children of the sons wear two bags, and each married daughter and son-in-law wears one bag. Mourning badges must also be made—wristlets of white for

all the sons, and wristlets of blue for all the grandsons. These are to be worn on the seventh day, and thereafter until they drop off through decay. The women must also make new red shoes for themselves, and cover them with sackcloth, and must make new mourning garments, or else sew shreds of white cotton along the seams and edges of their old tunics, to make them look like unfinished dresses that have been put on under the stress of sad circumstances.

On the seventh day after the demise, the deceased is supposed to become aware that he has departed this life, and on that day is performed the ceremony of accompanying him to the land of shades. Priests, Buddhist and Tauist, have been engaged for a fixed sum of money, with their entertainment, tobacco to smoke, tea to sip, and at least three substantial meals. Early in the morning the sons and daughters-in-law put on tunics of coarse sackcloth. The sons wear shoes patched with linen, a small or a large patch on the toe indicating whether one or both parents are dead. They put on a tall cap of sackcloth having a wad of spirit-money suspended on either side to dangle over the ears and shut out the criticisms of relatives who may be dissatisfied with their management of the funeral rites or with the quality of the repasts provided for the assisting mourners.

The Buddhist priests arrive and hang upon the white screen three pictures of Buddha, which are worshiped by the members of the bereaved family, especially by its women. Water is heated for the deceased to bathe in, and is put into a tub beside the coffin, and inclosed by a new mat. A paper towel and a complete suit of paper clothing are burned beside the coffin to furnish the spirit with suitable attire for the day's exercises. The Buddhist priests meanwhile chant an invitation to make use of the things provided. They continue to chant at intervals during the day, acting in concert with the Tauist priest, who takes the lead in conducting the spirit to hades. For one or three days and nights, according to the wealth and faith of the family, the priests continue their incantations, ringing bells, sprinkling the altar with holy water from a pomegranate-branch, and burning incense whose smoke fills the court. A plank is supported at its ends by two stools, and represents bridges. The Tauist priest, followed by the eldest son carrying an armful of copper coins, and by all the rest of the family in file carrying lighted incense-sticks, goes on a circuit through the house, court, or street, repeatedly crossing the mimic bridge. This is the exponent of the long journey made by the deceased across marshes, meadows, streams, and mountains toward the bourn from which no traveler returns. After many wearisome circuits, the priest stops and calls for the opening of the gate into hades. An assistant responds that the gate-keeper's fee

must first be paid, and the eldest son throws coins into the priest's bowl. After a turn or two more, the call is repeated, the invisible door is opened, and the spirit is supposed to pass in and to mount a lofty platform, from which it takes a final view of the house and village in which it has dwelt. The priests chant its valediction, saying:

"On the last, highest lookout now I stand,
And gaze toward home, with weeping loud and sore:
Those who go farthest on an earthly strand
May come again to kin and native land,
But he who enters hell returns no more."

The mourners wail loudly, and the spirit is considered to have departed into the realm of shadows. The party led by the priest now take the short return journey, crossing the mimic bridge but once; for they say:

"For going, ages scarce suffice;
The coming back takes but a trice."

The priest then brings a miniature artificial lotus-garden, on whose terraces are images of the immortals, and sets it whirling on its standard over a basin of clean water. The mourners throw coins into the basin, to secure an abundance of pure water for the use of the deceased in the nether world. Various arts are used by the priest, at this and other stages of the performance, to increase the amount of cash thrown into his basin.

At nightfall the offerings which supply the dead with the necessaries of spirit-life are sent to him by burning them. Silver and gold coins, clothing of every sort and in many colors, opium and tobacco-pipes, spectacles, wallets, boxes, horses, sedan-chairs, boats, and servants, counterfeited skillfully in paper, and costing hundreds of dollars, are offered by the descendants and friends of the deceased, and are consumed in little bonfires that fill the court-yard with flame, smoke, and ashes. Married daughters bring armfuls of paper clothing and add it to the blaze, kneeling and leaning their heads against a bar from their looms. Neighbors and acquaintances bring packages of similar goods, and commit them, through the flames, to the care of the deceased, to be transferred by him to their own relatives in the region to which he is going. Some offer real articles, which are spread on tables, with edibles, and these are usually carried away during the night by poor souls still in the flesh. Supplies of paper goods are also burned for the poverty-stricken and friendless dead, who might without this pacification rob the beloved traveler of the things intended for his sole behoof. All night the fires glow, the smoke ascends, the priests chant, and the mourners wail.

On the morning of the eighth day the priests usually depart, and the family resumes, in some degree, its ordinary occupations. Three times, at the new and the full moon, the married daughters of the deceased each bring a pig's head and a large steamed cake, and join their brothers in worship before the seat of the spirit in their father's house. On the sixth day of the sixth Chinese month, after the removal of the seat of the spirit, the sons buy one cock, one water-melon, cakes, and incense, and offer them to their father's spirit, that being the day on which he, having been judged before ten courts in hades, crosses its narrow bridge and passes into a region decreed to him according to his deserts. The cock wakens him, and is afterward presented by him to the keeper of the bridge; the melon and cakes are distributed on the route, and the incense is burned in ceremonious respect to the deceased. After the first hundred days the dead parent receives offerings of food, with the burning of incense and spirit-money, about ten times a year, including always his birthday and the anniversary of his death

White is, in a general way, the color of mourning. Sons, during the first three days, wear the tunic wrong side out, and on one side of the body only. After that time they wear, like other mourners, garments of unbleached hempen cloth, except on the seventh day, when they and their wives wear sackcloth tunics, usually hired from a shop at which coffins are sold. The sons do not shave their heads for one hundred days, and they wear mourning for twenty-seven months, during which time they can not legally marry. Daughters and daughters-in-law put off mourning at the end of one year, when they resume their golden head-ornaments and don some bit of red.

The burial of the encoffined body is sometimes deferred for many years, awaiting the death of a spouse, or the favorable decision of a geomancer concerning a site for a tomb. As the prosperity of every man's descendants is thought to depend upon his being laid in a spot having such relationship to wind and water as will afford him undisturbed repose, the selection of a place of interment is sometimes difficult, and there are men who make their living by searching out good places for graves.

The grave being prepared, friends are informed of the burial, and they assemble at the appointed time to follow the coffin to the hills. The coffin is covered with a red pall. Two lanterns are tied together with a red cord, and arranged so as to hang one on either side of the coffin; and there may be as many pairs of lanterns as there are married couples among the descendants of the deceased. Small bags, with a red and a green side, are also hung upon the coffin, one for each member of the mourning household. The bags contain linen thread, cotton-rolls, peas, rice, hemp-seed, and coins,

emblems of longevity, fecundity, and wealth. They have an occult influence on the weal of the living.

Before the procession moves, twelve bowls of soup, in which pellets of dough float, are offered, with prostrations, to the dead. The number twelve and the vernacular name of the pellets express completeness, and are a funereal charade. Four or more men, hired for high wages, bear the coffin. It is followed to the grave by male friends, all in mourning, with tall white caps. The women, with white scarfs on their heads, go but a short distance from the house to a fork in the road, where a lad has been stationed with a banyan-branch. There they burn incense, make obeisance to the coffin, break off a twig of the banyan, and return by a route other than the one by which they came. A convenient superstition preserves them from a long journey on their maimed feet, and declares that they "must not follow the dead to death."

The sons of the deceased carry each a staff of bamboo or of banyan, which is left at the grave. Spirit-money is scattered along the road to buy right of way from demons that might oppose. The coffin being lowered, each person in the procession takes up some mortar in the flap of his tunic and casts it into the grave. When the pit is filled and rounded, *sesame*, whose vernacular name means completion, is planted on the top, to grow in sun and rain. A new, small gilded image, that has been brought with the coffin to the tomb, has a dot added to a hieroglyphic upon it, changing the meaning of the said hieroglyphic from *king* to *lord*. At this instant it becomes a household god, and is carried back with reverence to be placed on the shrine of the lares in the house, and worshiped with oblations.

During three years, on the anniversary of the death, presents of paper clothing are sent to the deceased by burning them. So long as there are male descendants living, they worship the grave in the seventh month of each year. When the family becomes so large that a division of the estate and separate dwellings are expedient, the images of the progenitors are inherited by the eldest son.

MR. BALFOUR would make interest the ultimate criterion in the selection of reading for improvement. Knowledge is most easily attained in those subjects which we like most and take the most interest in. Our best course should be, having become interested in a subject, to read the best books upon it. By this rule we will read widely, and perhaps superficially; but thus reading, with freshness and vigor eager to be enlightened on this particular thing, will we not get more knowledge and be vastly more benefited than the man "who, with slow and painful steps, wearily plods through a list of books, though that list has in it all the masterpieces of creation"?

EYE-MINDEDNESS AND EAR-MINDEDNESS.*

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THE faculty that determines the direction of one's mental acquisitions has been termed "apperception"; it is equivalent to all that the mind brings with it *to perception*. Steinthal has made clear the nature and importance of this trait by a variety of clever illustrations. One of these relates to a party of German gentlemen who had traveled together all day, and as they were about to separate one of their number offered to tell the profession of each of the party if each would write without hesitation an answer to the question, "What destroys its own offspring?" One wrote, "Vital force." "You," said the questioner, "are a biologist." A second answered, "War," and was correctly pronounced a soldier. The philologist revealed his profession by writing "Kronos"; the publicist by writing "Revolution"; and the farmer by writing "She-bear." Each answered according to his apperceptive bent. The same thing is illustrated in Don Quixote's seeing a giant in a windmill; in our seeing a man in the moon; in the ancients finding curious animal shapes in the constellations; in children's and savages' personification of animals and natural phenomena; in Macbeth's vision of the dagger; or in the advice of that wise priest who told a maiden consulting him as to her acceptance of a certain suitor, to listen to the church-bells, and if she heard them saying, "*Take*-him, *take*-him," her happiness lay in acceptance, while if the bells rang out, "*Take*-him-*not*, *take*-him-*not*," no good could come of the union. The issue is left in doubt, but the maiden certainly followed her own mind. Especially when distinct perception is difficult does the subjective element of the process come to the front. In a country walk at night, an imaginative person constantly sees a ghost in what his more prosaic companion recognizes as a whitewashed tree. At a spiritualistic *séance*, it is well known that enthusiastic believers see whatever they are anxious to see. The general formula which sums up all these illustrations is, that we see with all that we have seen; we hear with all that we have heard; we learn with all that we have learned, and so on. Every acquisition and every action, however trivial, leaves a mark on our organization and becomes a causal link in the rest of our lives; it is in this way that experience leaves its deposit in character. This apperceptive

* The treatises dealing most fully and ably with the general subject of this article are G. Ballet's "Le langage intérieur et les diverses formes de l'aphasie," and V. Egger's "La parole intérieure"; see also S. Stricker's "Sprachvorstellungen," etc.

bent goes deep into human nature, and it is transmitted to our offspring; it reveals itself early in life, is a most valuable guide-mark to the educator, and plays a prominent *rôle* in the development of enthusiasm and of genius. It is one aspect of this important trait that is here to be treated—an aspect best described as "sensory apperception"—the part of our individual bent due to the relative intellectual importance of the several senses.

Man is a visual animal; as a race we are eye-minded. We regard "seeing as believing," and say we "see" when we comprehend. The language of every-day use, as well as the imagery of poetry, abounds in illustrations of the "pictorial" nature of thought. Primitive forms of "picture-writing" testify to the ease with which the eye takes the lead in expressing ideas; and modern civilization increases a hundred-fold this natural visual supremacy, which by some is regarded as originally due to the function of sight as a distance-sense ("anticipatory touch" of Spencer). The use of object-lessons, models, diagrams, the reduction of complex relations to the curves of the graphic system, and a host of similar devices,* all show how firmly the eye is the apprehensive organ of mankind, and how generally its educational value is appreciated. While, as a genus, we are eye-minded (in the same sense in which we might call a dog smell-minded), certain portions of the *genus homo* possess this faculty to a greater degree than others. Women visualize more distinctly than men; children think more vividly than adults; the French are (or were) noted for the skill with which they can foresee the effect of dress-combinations, festal decorations, and the like, and their phrase for "imagine" is "*figurez-vous.*" Similar individual variations have been well brought out by the studies of Mr. Francis Galton.† From the examination of a large number of answers to a long series of questions, he concluded that the brightness, vividness, and reality of the mental picture of a former experience varied in different persons from all absence of any pictorial element in the remembrance to a remembrance comparable to a colored photograph of the original scene. In describing their remembrance of the morning's breakfast-table, some saw it all bright, definite, and complete; the persons present, their costume, the dishes, the view—all stood out as in the actual scene. Another group could visualize only the main features; the picture lacked reality, omitted details, and was only fairly clear; while a third set could

* Perhaps the most striking device is that of teaching children the tones of the scale by association with colors (also with position of the hand, etc.); thus *do* would be red, *mi* yellow, etc. The association is explained (?) as due to a similar emotional effect of the sound and the color. I have heard a class of children sing from colors, and set up tunes in the same way.

† "Inquiries into Human Faculty," London, 1883.

hardly picture anything at all: they remembered the scene as they would a poem, but they saw nothing. Mr. Galton also finds that form is pictured better than color; that a high degree of visualizing power is apt to be hereditary; that scientific men as a class are poor visualizers, owing to their busying themselves with abstractions and generalizations, in which such a faculty would be inconvenient and thus fail to be cultivated; and many other interesting conclusions. When properly trained, and prevented from checking the plastic growth of mind, this faculty should be as useful an educational aid as the possession of a strong memory; like the latter, it is no mark of high intellectual capacity, but can be made a means of attaining it.

Some extreme and almost abnormal forms of this visualizing power are interesting in this connection. Examples of its extreme development are found in chess-players who play many games at once while blindfolded; in orators who "see" the pages of their manuscript as they speak; in mechanicians who picture every detail of construction and action of a machine in process of invention; in "lightning-calculators," who do their work on an imaginary blackboard; in artists painting a portrait or copying a painting from memory; and in countless others. Perhaps the crowning example is that of two chess-players, both gifted in this way, who could play a game of chess as they walked the streets; each announcing his move, and securely and readily picturing the result on their imaginary chess-board.

A strange development of this faculty (which, when it occurs, occurs almost always in conjunction with a strong visualizing power) is seen in certain imperative associations between colors or forms and sounds. The most common example is what Mr. Galton terms a "number-form." Many persons, when hearing or even thinking of a number or of a series of numbers, see these numbers arranged in definite shapes in a definite part of space. Some see them in the form of a circle; some as a broken line, the numbers 10, 12, 20, and 100 usually standing at the angles; and others have a variety of more complex and fantastic shapes. The letters of the alphabet—especially the vowels—the names of the months, of the days of the week, of persons and places, musical sounds, and so on, are associated in this realistic way with forms and colors. One gentleman has actually a whole alphabet of sound-colors, and can paint the sounds of *v-i-s-u-a-l-i-z-a-t-i-o-n* in colors, or read words out of wall-paper patterns.*

That such powers easily shade into the morbid is not hard to believe. Many of the chess-players who play blindfolded are

* Further examples and much interesting information are to be found in Mr. Galton's papers, *loc. cit.* (where are also illustrative diagrams and plates), and in "Zwangsempfindungen durch Licht und Schall," by Bleuler and Lehmann, 1881, a small monograph.

haunted by the chess-board at night. An artist painting an imaginary portrait saw the figure in his walks, saw it move, at length came to believe in its reality, and became insane. The creations of genius are sometimes similarly realized: Dickens walked the streets with "Little Nell" at his side. All such phenomena are likely to appear as visual; in dreaming, these are decidedly most frequent and prominent (in fact, we call a dream a "vision"); in hypnotism an imaginary visual sensation is easily induced; in incipient as in pronounced insanity, visual illusions and hallucinations are the most usual.

All these facts illustrate the leading *rôle* that vision plays in mental life—or, to speak physiologically, the high development of the cortical sight-center in man and its associative dominance over other cortical centers—as well as the great variety of its development in different individuals. Next to sight, the intellectually most valuable sense is hearing; that it owes much of this importance to its function as the medium of spoken language goes without saying. As in sight, so in hearing, the ease of perception and the clearness and accuracy of one's remembrance of musical or other sounds are subject to wide individual variations. Again, there are persons who possess this "auditizing" power to an unusual degree; to this class belong Mozart, who remembered the "Miserere" of the Sistine Chapel after two hearings; Beethoven, composing and silently repeating to himself whole symphonies after his deafness; "Blind Tom," performing any musical composition, however fantastic, after a single hearing, and so on. In ordinary experience, many persons reveal their dependence on auditory impressions by repeating things out loud to remember them, by closing their eyes and assuming the attitude of listening when trying to recall a word, and so on. Among the blind I have found many a good example of this type of mind, just as good visualizers are probably abundant among the deaf-mutes. A good illustration of the difference between what I shall term a "*visionaire*" and an "*auditaire*" is furnished by the conversation between the two dramatists, Legouvé and Scribe. "When I write up a scene," said Legouvé to Scribe, "I *hear* it; you *see* it; for every phrase I write, the voice of the character speaking it strikes my ear. You are the theatre itself; your actors walk and act under your eyes; I am of the *audience*, you of the *spectators*." "Nothing could be truer," said Scribe.

Instances in which certain forms or colors call up certain sounds are on record, though they occur much less frequently than the reverse. In one case the sight of the full moon looked at through a red glass has the sound of *l* joined to *o*. In dreams, hearing enters next frequently to sight (though in many cases the tactual-motor sensations predominate); in hypnotism an auditory

suggestion is very easily imposed; to the blind, hearing is decidedly the most valuable sense; and illusions and hallucinations of hearing are only slightly less frequent than those of sight. In general, the intellectual nature of these two senses presents a similar scale of individual differences, and suggests the action of like causes in their education as in their decay.

Third in importance is the group of muscular and tactual sensations accompanying motion. The importance of these is shown by the large factor of mere imitation in all training. The speaking of a language, though guided by the ear, and lost when hearing fails in childhood, is yet a separate acquisition, and deaf-mutes can be taught to speak by the muscular feelings alone. This avenue of knowledge was sufficient to bring to Laura Bridgman her phenomenal education. In common experience the value of this sense is illustrated by the tendency of many persons to speak to themselves, to move their lips when reading, to go through the motions of touching the keys of a piano when listening to a musical recitation. Many artists lay much stress on the teaching of free-hand movements apart from pencil and paper; singers often state that they "feel" an aria in their throats when they go over it to themselves; actors and athletes are, perhaps, likely to develop this kind of mental faculty, and among blind handicraftsmen it is frequent; while a certain school of psychologists define thinking as restrained action. The difficulty in estimating the importance of this sensory group to our intellectual fabric lies in the fact that it acts almost entirely under the guidance of the eye or of the ear; but analogy makes it probable that its importance varies much in different individuals. Such sensations enter into dreams, play a prominent *rôle* in hypnotism, where the assumption of an attitude will bring about the corresponding emotion, and have much to do in developing a common type of illusions and hallucinations. (Here belong the persecutions by crawling vermin, the feeling that the body is made of glass, or that the walls of the chest touch one another, and the like.)

Smell and taste need only a bare mention. The intellectual value of these senses reaches its climax in the lower animals.* Smell is a richly suggestive sense (witness the associations with the odor of funeral flowers, and the like), and taste gives us many emotional epithets, such as a "sweet" disposition. But our mentality has developed in other directions, and these senses have remained nearest to the conæsthesic stage.

Every normal-minded man uses each of the above avenues of knowledge in his mental processes, as well in acquiring as in retaining and digesting mental food. Certain acquisitions depend

* Perhaps the eccentric Dr. Jäger, who finds the seat of the soul in smell, is an unusual case of smell-mindedness—a highly developed "olfactaire."

almost exclusively upon the development of one intellectual center (music upon the auditory, painting upon the visual); and one in whom this center is poorly developed is deprived of all but mediocre achievement in that direction. But a far larger share of mental work is done by the combined use of various centers; and here, in what one does best by using the eye as the leading sense, another may succeed better by employing the ear as the teacher. The learning of one's mother-tongue is probably the best example of the operation in question. (A remark must be here inserted regarding the acquiring and the retaining of knowledge. It may be that one sense acquires knowledge readiest and another retains it best. But the utility of either process is so generally dependent upon the soundness of the other that we have good reason to believe that cases where different senses take charge of the two processes would be the exception. However, the question can only be settled by an experimental test. In general, the different sensory types will be supposed to refer to the combined process of memory and apperception, with the reservation, in necessary cases, of the possible difference just referred to.) In learning a language, one must first associate certain ideas with certain sounds, and again with the accompanying feelings of the vocal apparatus when making the sounds, and again with a certain set of visual symbols (usually more than one set—capitals, small letters, printed characters, script, etc.), and again with a set of muscular feelings when writing. And all this—the work of years—can be further complicated by the knowledge of several languages, of short-hand, and so on. In spite of this wonderfully complex and compact interassociation of the elements of language—as expressive of the intellectual utilization of sense-impressions—each sense keeps its store of images and its apperceptive grasp quite distinct. Pathology demonstrates that the distinctions here made are not abstractions, but have correlated with them separate physical substrata in the cells of various parts of the cortex; disease can paralyze any one of these cell-groups, shutting off one part of the language complex, and leaving all others quite intact. A few cases of this kind will bring out very clearly the distinctions in types of memory and apperception here treated. Dr. Charcot records the most striking case: A highly intelligent gentleman, well versed in several languages, was gifted with a remarkable visual memory. He could read pages of his favorite authors from the mental image of the printed page; he could sketch well from memory; and the mention of a scene in a play or of an incident of any of his many travels at once called up a bright and complete picture of the entire scene. He had, however, no fondness for music, and what he heard impressed him very little. As a consequence of business troubles, he became nervous and irritable.

With this his visual apperception and memory gave way. The scenes of his daily walks seemed strange; if asked to picture a certain spot, he was unable to do so; the attempt to draw a church-spire resulted in a rude, childish scrawl. Later on, the familiar scenes of his childhood faded from his memory; he could not picture the appearance of his wife and child, and even failed to recognize his own image in a mirror. In order to keep up his literary tastes, everything had to be *read out loud* to him; he had to cultivate his little-used auditory center. He now no longer dreamed of seeing, but of hearing. In short, without impairment of vision or of general intelligence, his excellent visualizing powers faded out, and he was left dependent upon his auditory center. By nature a strong "visionaire," disease forced him to become an "auditaire."

In sensory aphasia, cases occur in which the patient can not understand *spoken* words; he may be able to speak himself, can write, and has no defect of hearing. But the power to apperceive, to get the meaning out of sounds, is lost. The same may happen to the function of the *motor* sense in written language. In a typical case the patient suddenly lost all power to write; he had no paralysis, could read manuscript, could talk and hear. But the knowledge of the movements necessary to form the letters had dropped from his mind. If the disease progresses, he may lose the knowledge of all those little gestures and facial expressions that fill the gaps of social intercourse. In these cases—and more varieties could be added—we have clearly illustrated the distinctness of each of these sensory faculties, and of the various degrees of importance they assume in different minds.

It will doubtless have occurred to many a reader that this natural difference of faculty has a practical, an educational aspect. If each one can best absorb his mental food in a certain way, a knowledge of the nature of this peculiarity is certainly desirable. An absence of this knowledge is certain to bring about waste of energy, and especially so as these differences are already apparent in early youth, when a proper recognition of them can do something to remove the unnecessary friction of school-room methods. Dr. J. Mortimer-Granville has clearly grasped the practical aspect of this principle in his primer on "The Secret of a Good Memory." The leading note of that essay is the necessity of finding out the sensory bent of one's memory, and following out the clew thus gained. An eye-minded person should read, should reduce everything to visual terms; and it is because of the common occurrence of this trait that such mnemonic systems as associate everything with a certain spot on a general scheme have been successful. To an "auditaire" they would be worse than useless. The latter must have things read to him; will gain much

from conversation, and so on. Dr. Granville does not recognize the motor-type, but gives a series of tests for distinguishing between an eye-minded and an ear-minded person, which, in brief, are as follows: Unknown to the subject of the trial, a slip of paper containing some eight or ten monosyllabic words, arranged so as to have no natural association, is prepared and presented to him to be *silently read once only*. He must then write as many of the words as he can remember. The same is repeated with an equivalent set of words *read aloud once* to the subject, which he attempts to repeat. A comparison of the errors in a number of papers prepared in this way will reveal whether the words are better apprehended by the eye or by the ear. By having a longer or shorter interval between the reading and the repeating, the sense by which the subject *remembers* more securely will be determined.

The test is good but insufficient; a reliable and complete estimate of the part played in one's mental life by the several senses can be gained only by a series of varied and mutually corroborative tests. A few such tests which I have tried and found satisfactory—and which will readily suggest others—will be here detailed.

The general principles on which I proceed are three: I. I test the *limit* of the capacity for receiving impressions by the eye, and a similar limit for the ear. The sense that has the largest capacity is the dominant one. II. I test the subject in a performance in which error is sure to occur, both by eye and by ear, and compare the *amount* of the error in equally difficult performances, as well as derive hints from the *nature* of the errors. III. I have two processes, one requiring the use of the eye, the other that of the ear, going on *at the same time*; and find which one absorbs the maximum of attention and gets best remembered. All of these principles admit of a variety of applications, both for immediate apperception as well as for remembrance after an interval.

I. The simplest test relates to the mechanical apprehension of form and sound. For this one can find the maximum number of nonsense-syllables that can be repeated after a single reading, and compare it with the number remembered after a single hearing. One can do the same with numbers, with words of a foreign tongue, with simple diagrams or colors and sounds, and so on. The "visionaire" remembers more of the seen; the "auditaire" of the heard. The next step is to use significant words, as Dr. Granville suggests. It is still more instructive and often amusing to take short sentences from the newspaper or a book and find the largest number of words in construction retained after a single hearing or a single reading. Another interesting test is to find the num-

ber of repetitions necessary to commit a paragraph or a string of words too long to be retained after a single hearing or a single reading; here, as everywhere, care must be taken to have the paragraphs of equal difficulty, and to repeat the test a number of times. Dr. Ebbinghaus * has made a valuable study of the memory, tracing a curve of forgetfulness, and establishing many interesting conclusions by this method; while Mr. Joseph Jacobs † and others have used the maximum number of sounds repeatable after a single hearing, which they call the "span," as a test of the growth of mental power with the increase of years, and as a mark of the narrow intellect of idiots. The successive corrections and improvements, until a perfect repetition is possible, are often full of interest. The "auditaire" reaches this stage sooner by having the passage, etc., read, the "visionaire" by reading it; in addition I find that the former has all along (both in I, II, and III) a tendency to remember the *last* words best, while the latter retains the *first* most readily. One must also observe by which method the sense is best retained when the exact words are forgotten; moreover, it may be noted that the one confuses words allied in sound, the other words are in appearance, and so on.

II. All the various processes described under I can be repeated with the list of words, numerals, paragraphs, and the rest, so long that error is sure to arise. It is not necessary to give details. These errors are often highly amusing as well as instructive. The fleetness with which an impression which you feel perfectly sure of firmly possessing while listening or reading, suddenly disappears with a blank in its place, is very startling. After an interval, only the most prominent words or ideas are left. Of three persons subjected to a variety of tests, one retained most and more of what the eye had taken in, the second nearly equally of each, with a preponderance of the visual, while the third (myself) was a decided "auditaire." This suggests the remark that a type of mind to which all the avenues of perception are almost equally attractive is doubtless common. In fact, M. Binet,‡ who has much interesting matter to offer on this topic, regards this indifferent type as the normal type, representing a harmonious development of all the sensory faculties. But here, as elsewhere, specialization has its advantages; and, moreover, if the tests are carefully made, I suspect a noticeable superiority in favor of sight will be the most usual result. It is not impossible to imagine the tests so arranged as to give roughly quantitative estimates of the relative impor-

* Hermann Ebbinghaus, "Ueber das Gedächtniss," Leipsic, 1885. An excellent monograph.

† "Mind," January, 1887; an article by Mr. Jacobs *et alii* and another by Messrs. Galton and Bain.

‡ Alfred Binet, "La Psychologie du Raisonnement," Paris, 1886.

tance of the several senses in this respect, and thus register the *degree* to which one is a "visionaire," "auditaire," and so on.

III. These form the most difficult as well as most interesting tests. Two paragraphs (of course, the same can be done with syllables, numerals, words, and so on), of equal difficulty are chosen, and, while one is *read by* the subject, the other is *read aloud to* him. The reading must not be especially loud or pronounced, but neither must it be monotonous. It is very important that, in repeating as much as possible of the contents of both paragraphs, one should as often repeat *first* what has been read as what has been heard. The amount of forgetting of the other paragraph that goes on while you repeat what you can of the one, is surprising. In this performance, appealing simultaneously to eye and ear, the "auditaire" is attracted to what he hears, the "visionaire" to what he sees, and the former knows more of what has been read, the latter of what he has read. A strong "visionaire" may, at times, know nothing of the passage read to him, while the "auditaire" may listlessly let his eye wander across the page, his attention being involuntarily chained to what he hears.

A modified form of this test can be adopted by finding the *limit* of words, etc., that can be perfectly learned by the eye and ear simultaneously. While the "auditaire" can listen to and retain six words, he may be able to read and retain (at the same time) only two or three words; while with the "visionaire" the propositions will be reversed. That it is possible to do these two things at once is shown by some ingenious experiments of M. Paulhan.* This observer finds that the more disparate the faculties used in doing two things at once, the better can they be done; and that the simpler the processes, the less the difference between the sum of the times necessary to do each separately and the time to do both at once, this difference failing entirely in very simple processes. When the two sentences get confused it is suggestive to note whether a heard word creeps into the passage read, or *vice versa*.

If a person is an "auditaire," a further test of the degree of this trait can be thus made: While a passage is being read to him, let him copy a sentence or two from a book. If a strong "auditaire," he will find that he has been writing automatically, knows little of what he has written, and can tell more or less of what he has heard. The "visionaire," on the other hand, knows what he has written almost word for word, and less than usual of what has been read to him. That is, with a strong "auditaire," hearing outweighs sight even when supported by the muscular sense; while, when thus supported, sight more than usually outweighs hearing for the "visionaire."

* "Revue Scientifique," June, 1887; reported in "Science," July 8, 1887.

A few words should be said about those to whom action is the chief aspect of mental experience—the "motaires." I have not succeeded in devising a satisfactory test for the importance of this avenue of knowledge in our mental fabric, for the obvious reason that it operates so generally under the guidance of the eye or (in speaking) of the ear. (It would be easier to devise tests applicable to the congenitally blind.) Even when we write or draw with closed eyes, we imagine and interpret what we do by how it will look. A few hints as to the strength of this faculty can be gathered from some of the above and similar experiments. In the last test, for example, he who would be decidedly aided by writing what he read would be somewhat strongly motor-minded; while this trait would be weak in one not much aided by writing what he reads. Again, one might find the limit of memory for words, sentences, etc., written from a copy and again written from dictation, and observe which the motor feelings aided more and how much altogether; one can also have the hand moved by another, drawing a more or less complicated figure, and compare the attempt to repeat the drawing with a similar repetition of a drawing momentarily seen. These tests—for which the average of a large number of trials is necessary as a standard—would be certain to bring out decided "motaires," but they must be perfected before they are as available and conclusive as those for ear- and eye-mindedness.

It goes without saying that every one will probably have a hint (though often only a slight one) as to the sensory bent of his apperceptive processes, especially any one engaged in mental labor. If he is a "visionaire" he will have noted how much better he remembers what he reads than what he hears; that he often remembers the position of a word on a page; will, perhaps, have a good memory for forms and faces; will find that he can easily read while talking is going on; that he readily gets absorbed when his eye is occupied; and so on in a hundred ways. The "auditaire" will note that a lecture impresses him more deeply than a review article; that he imagines the sounds of the words as he reads or writes (and is usually thus a slow reader); that he repeats aloud what he has written to judge of its effect—he wants to know how "it sounds" even when it is only to be read; he observes harsh sound-combinations in style (the "visionaire" observes misprints); talking easily disturbs him when reading or writing, his attention being involuntarily drawn to the conversation; he may have a good memory for tunes, and so on. Those who approach the motor or the indifferent type will have greater difficulty in discerning this by hap-hazard observation. The above are, of course, only general descriptions; they will be variously modified in individual cases, but will retain a typical ap-

pearance throughout. Enough has been said to indicate the diversity of various minds in these respects, and the importance of recognizing and studying these distinctions, alike for their educational utilization and as a contribution to a scientific psychology.

ANTAGONISM.*

By Sir WILLIAM R. GROVE, F. R. S.

SOME months ago, shortly after I had resigned my office of Judge of the High Court, I was expressing to a friend my fear of the effect of having no compulsory occupation, when he said, by way of consolation, "Never mind, 'for Satan finds some mischief still for idle hands to do.'" You may possibly in the course of this evening think he was right. I have chosen a title for my lecture which may not fully convey to your minds the scope of the views which I am going to submit to you. I propose to adduce some arguments to show that "antagonism," a word generally used to signify something disagreeable, pervades all things; that it is not the baneful thing which many consider it; that it produces at least quite as much good as evil; but that, whatever be its effect, my theory—call it, if you will, speculation—is that it is a necessity of existence, and of the organism of the universe so far as we understand it; that motion and life can not go on without it; that it is not a mere casual adjunct of Nature, but that without it there would be no Nature, at all events as we conceive it; that it is inevitably associated with unorganized matter, with organized matter, and with sentient beings.

I am not aware that this view, in the breadth in which I suggest it, has been advanced before. Probably no idea is new in all respects in the present period of the world's history. It has been said by a desponding pessimist that "there is nothing new, and nothing true, and nothing signifies," but I do not entirely agree with him; I believe that in what I am about to submit there is something new and true in the point of view from which I regard the matter; whether it signifies or not is for you to judge. The universality of antagonism has not received the attention it seems to me to deserve from the fact of the element of force, or rather of the conquering force, being mainly attended to, and too little note taken of the element of resistance unless the latter vanquishes the force, and then it becomes, popularly speaking, the force, and the former force the resistance.

There are propositions applying more or less to what I am going to say of some antiquity. Heraclitus, quoted by Prof. Huxley,

* Lecture delivered at the Royal Institution of Great Britain, on April 20, 1888.

said, "War is the father and king of all things." Hobbes said war is the natural state of man, but his expressions have about them some little ambiguity. In Chapter I of the "De Corpore Politico," he says, "Irresistible might in a state of Nature is right," and "The estate of man in this natural liberty is war." Subsequently he says, "A man gives up his natural right, for when divers men having right not only to all things else, but to one another's persons, if they use the same there ariseth thereby invasion on the one part and resistance on the other, which is war, and therefore *contrary to the law of Nature, the sum whereof consisteth in making peace.*" I can only explain this apparent inconsistency by supposing he meant "law of Nature" to be something different from "the natural estate of man," and that the making peace was the first effort at contract, or the beginning of law; but then why call it the "*law of Nature*," where he says might is right? There is, however, some obscurity in the passage. The Persian divinities, Ormuzd and Ahriman, were the supposed rulers or representatives of good and evil, always at war, and causing the continuous struggle between human beings animated respectively by these two principles. Undoubtedly good and evil are antagonistic, but antagonism, as I view it, is as necessary to good as to evil, as necessary to Ormuzd as to Ahriman. Zoroaster's religion of a divine being, one and indivisible, but with two sides, is, to my mind, a more philosophical conception. The views of Lamarck on the modification of organic beings by effort, and the establishment of the doctrine of Darwin as to the effects produced by the struggle for existence and domination, come much nearer to my subject. Darwin has shown how these struggles have modified the forms and habits of organized beings, and tended to increased differentiation, and Prof. Huxley and Herbert Spencer have powerfully promoted and expanded these doctrines. To the latter we owe the happy phrase, "survival of the fittest"; and Prof. Huxley has recently, in a paper in the "Nineteenth Century," anticipated some points I should have adverted to as to the social struggles for existence. To be anticipated, and by a very short period, is always trying, but it is more trying when what you intended to say has been said by your predecessor in more terse and appropriate language than you have at your command.

I propose to deal with "antagonism" inductively—i. e., with facts derived from observation alone—and not to meddle with spiritual matters or with consequences. Let us begin with what we know of the visible universe, viz., suns, planets, comets, meteorites, and their effects. These are all pulling at each other, and resisting that pull by the action of other forces. Any change in this pulling force produces a change, or, as it is called, perturbation, in the motion of the body pulled. The planet Neptune, as

you know, was discovered by the effect of its pulling force on another planet, the latter being deflected from its normal course. When this pulling force is not counterbalanced by other forces, or when the objects pulled have not sufficient resisting power, they fall into each other. Thus, this earth is daily causing a bombardment of itself by drawing smaller bodies—meteorites—to it; twenty millions of which, visible to the naked eye, fall on an average into our atmosphere in each twenty-four hours, and of those visible through the telescope, four hundred millions are computed to fall within the same period. Mr. Lockyer has recently given reasons for supposing the luminosity of nebulæ, or of many of them, is due to collisions or friction among the meteorites which go to form them; but his paper on the subject is not yet published.

What is commonly called centrifugal force does not come from nothing; it depends upon the law that a body falling by the influence of attraction, not upon, but near to, the attracting body, whirls round the latter, describing one of the curves known as conic sections. Hence, a meteorite may become a planet or satellite (one was supposed to have become so to this earth, but I believe the observations have not been verified); or it may go off in a parabola as comets do; or, again, this centrifugal force may be generated by the gradual accretion of nebulous matter into solid masses falling near to, or being thrown off from, the central nucleus, the two forces, centrifugal and centripetal, being antagonistic to each other, and the relative movements being continuous, but probably not perpetual. Our solar system is also kept in its place by the antagonism of the surrounding bodies of the cosmos pulling at us. Suppose half of the stars we see—i. e., all on one side of a meridian line—were removed, what would become of our solar system? It would drift away to the side where attraction still existed, and there would be a wreck of matter and a crash of worlds. It is very little known that Shakespeare was acquainted with this pulling force. He says, by the mouth of Cressida—

> "But the strong base and building of my love
> Is as the very center of the earth
> Drawing all things to it"—

a very accurate description of the law of gravitation, so far as this earth is concerned, and written nearly a century before Newton's time.

But in all probability the collisions of meteorites with the earth and other suns and planets are not the only collisions in space. I know of no better theory to account for the phenomena of temporary stars, such as that which appeared in 1866, than that they result from the collision of non-luminous stars, or stars previously invisible to us. That star burst suddenly into light, and

then the luminosity gradually faded, the star became more and more dim, and ultimately disappeared. The spectrum of it showed that the light was compound, and had probably emanated from two different sources. It was probably of a very high temperature. If this theory of temporary stars be admitted, we get a nebula of vapor or star-dust again, and so may get fresh instances of the nebular hypothesis.

Let us now take the earth itself. It varies in temperature, and consequently the particles at or near its surface are in continuous movement, rubbing against each other, being oxidized or deoxidized, either immediately or through the medium of vegetation. This also is continuously tearing up its surface and changing its character. Evaporation and condensation, producing rain, hail, and storms, notably change it. Force and resistance are constantly at play. The sea erodes rocks and rubs them into sand. The sea quits them and leaves traces of its former presence by the fossil marine shells found now at high altitudes. Rocks crumble down and break other rocks, or are broken by them; avalanches are not uncommon. The interior of the earth seems to be in a perpetual state of commotion, though only recurrent to our observation. Earthquakes in various places from time to time, and, doubtless, many beneath the sea of which we are not cognizant, nor of other gradual upheavals and depressions. Throughout it nothing that we know of is at rest, and nothing can move without changing the position of something else, and this is antagonism. Metals rust at its surface, and probably they or their oxides, chlorides, etc., are in a continuous state of change in the interior. Nothing that we know of is stationary. The earth as a whole seems so at first sight, but its surface is moving at the rate of some seventeen miles a minute at the equator; and standing at either of the poles—an experiment which no one has yet had an opportunity of trying—a man would be turned round his own axis once in every twenty-four hours, while the earth's motion round the sun carries us through space more than a million and a half of miles a day. The above changes produce motion in other things. The earth pulls the sun and planets, and in different degrees at different portions of its orbit.

Before I pass from inorganic to organized matter, I had better deal with what may perhaps strike you as the most difficult part of my subject, viz., light. Where, you may say, is there antagonism in the case of light? Light exercises its force upon such minute portions of matter that until the period of the discovery of photography its physical and chemical effects were almost unknown. Such effects as bleaching, uniting some gases, and affecting the coloring-matter of vegetables, were partly known but little attended to; but photography created a new era: I shall advert

to this presently. The theories of light, however, involved matter and motion. The corpuscular theory, as you well know, supposed that excessively small particles were emitted from luminous bodies, and traveled with enormous velocity. The undulatory theory, which supplanted it, supposed that luminous bodies caused undulations or vibrations in a highly tenuous matter called ether, which is supposed to exist throughout the interplanetary spaces and throughout the universe so far as we know it. Some suppose this ether to be of a specific character, differing from that of ordinary gases, others that it is in the nature of a highly attenuated gas; but, whatever it be, it can not be affected by undulations or vibrations without being moved, and when matter is moved by any force it must offer resistance to that force, and hence we get antagonism between force and resistance. Light also takes time in overcoming this resistance, i. e., in pushing aside the ether. It travels no doubt at a good pace—about one hundred and ninety thousand miles in a second; but even at this rate, and without being particular as to a few millions of miles, it takes three years and a quarter to reach us from the star which, so far as we know, is the nearest to us, viz., α Centauri. The ether, or whatever it may be called, tenuous as it is, is not unimportant, though it be not heavy. Without it we should have no light and possibly no heat, and the consequences of its absence would be rather formidable. I believe you have heard Dr. Tyndall on this subject. Supposing the visible universe to be as it is now supposed to be, i. e., in no part a mere vacuum, there can be no force without resistance in any part of it.

But photography carries us further, it shows us that light acts on matter chemically, that it is capable of decomposing or forcing asunder the constituents of chemical compounds, and is therefore a force met by resistance. In the year 1856 I made some experiments, published in the "Philosophical Magazine" for January, 1857, which seemed to me to carry still further what I may call the molecular fight between light and chemical affinity, and among them the following: Letters cut out of paper are placed between two polished squares of glass with tin-foil on the outsides. It is then electrized like a Leyden jar, for a few seconds, the glasses separated, the letters blown off, and the inside of one of the glasses covered with photographic collodion. This is then exposed to diffuse daylight, and on being immersed in the nitrate of silver bath the part which had been covered with the paper comes out dark, the remainder of the plate being unaffected. (This result was shown by the electric-light lantern.) In this case we see that another imponderable force, electricity, invisibly affects the surface of glass in such a way that it conveys to another substance of definite thickness, viz., the prepared collodion, a change in the

chemical relations of the substance (iodide of silver) pervading it, enabling it to resist that decomposition by light which, but for some unseen modification of the surface of the glass plate, it would have undergone; and no doubt the force of light, being unable to effect its object, was reflected or dispersed, and instead of changing its mode of motion in effecting chemical decomposition, it goes off on other business. The visible effect is in the collodion film alone. I have stripped that off, and the imprint remains on it, the surface of the glass being, so far as I could ascertain, unaffected. Thus, in the film over the protected part, light conquers chemical affinity; in that over the non-protected part, chemical affinity resists and conquers light, which has to make an ignominious retreat. It is a curious chapter in the history of the struggles of molecular forces, and probably similar contests between light and chemical or physical attractions go on in many natural phenomena, some forms of blight and some healthy vegetable changes being probably dependent on the varying effects of light and conditions, electrical or otherwise, of the atmosphere.

Let us now pass on to organic life. A blade of grass, as Burke, I believe, said as a figure of speech, is fighting with its neighbors. It is robbing them, and they are trying to rob it—no agreement or contract, simply force opposed to force. This struggle is good for the grass; if it got too much nutriment it would become diseased. The struggle keeps it in health. The rising of sap in trees, the assimilation of carbon, the process of growth, the strengthening themselves to resist prevalent winds, and many other instances might be given, which afford examples of the internal and external struggles in vegetable life.

I will now proceed to consider animal life, and in this case I will begin with the internal life of animals, which is a continual struggle. That great pump, the heart, is continuously beating—that is, conquering resistance. It is forcing the blood through the arteries, they assisting in squeezing it onward. If they give way, the animal dies; if they become rigid and resist too much, the animal dies. There must be a regulated antagonism, a rhythmical pulsation, the very term involving force and resistance. That the act of breathing is antagonistic scarcely needs argument. The muscular action by which the ribs are made to open out and close alternately, in order to inhale and exhale air, and other physiological changes which I can not here go into, necessitate a continuous fight for life. So with digestion, assimilation, and other functions, mechanical and chemical forces and resistances come into play. Since this lecture was written, I have heard of a discovery made, I am informed, by Prof. Metschnikoff, and which has brought to light a singular instance of internal antagonism. He is said to have proved that the white corpuscles

of the blood are permanent enemies of bacteria, and by inoculation will absorb poisonous germs; a recurrent war, as it appears, going on between them. If the corpuscle is the conqueror, the bacteria are swallowed up and the patient lives. If the corpuscles are vanquished, the patient dies and the bacteria live, at all events for a time. If the theory is founded, it affords a strong additional argument to the doctrine of internal antagonism. Possibly, if there were no bacteria, and the corpuscles had nothing to do, it would be worse for them and the animal whom they serve.

Let us now consider the external life of animals. I will take as an instance, for a reason which you will soon see, the life of a wild rabbit. It is throughout its life, except when asleep (of which more presently), using exertion, cropping grass, at war with vegetables, etc. If it gets a luxurious pasture, it dies of repletion. If it gets too little, it dies of inanition. To keep itself healthy it must exert itself for its food; this, and perhaps the avoiding its enemies, gives it exercise and care, brings all its organs into use, and thus it acquires its most perfect form of life. I have witnessed this effect myself, and that is the reason why I choose the rabbit as an example. An estate in Somersetshire, which I once took temporarily, was on the slope of the Mendip Hills. The rabbits on one part of it, viz., that on the hill-side, were in perfect condition, not too fat nor too thin, sleek, active, and vigorous, and yielding to their antagonists, myself and family, excellent food. Those in the valley, where the pasturage was rich and luxuriant, were all diseased, most of them unfit for human food, and many lying dead on the fields. They had not to struggle for life, their short life was miserable, and their death early; they wanted the sweet uses of adversity—that is, of antagonism. The same story may be told of other animals. Carnivora, beasts or birds of prey, live on weaker animals; weaker animals herd together to resist, or, by better chance of warning, to escape, beasts of prey; while they, the herbivora, in their turn are destroying vegetable organisms.

I now come to the most delicate part of my subject, viz., man (I include women, of course!). Is man exempt from this continual struggle? It is needless to say that war is antagonism. Is not peace so also, though in a different form? It is a commonplace remark to say that the idle man is worn out by *ennui*, i. e., by internal antagonism. Kingsley's "Do-as-you-like" race—who were fed by a substance dropping from trees, who did no work, and who gradually degenerated until they became inferior to apes, and ultimately died out from having nothing to do, nothing to struggle with—is a caricature illustrative of the matter. That the worry of competition is nearly equivalent to the hardships and perils of military life seems proved to me by the readiness with which mili-

tary life is voluntarily undertaken, ill as it is paid. If it were well paid, half our men would be in the military or naval service, and I am not sure that we should not have regiments of Amazons! The increased risk of life or limbs and the arduous nature of the work do not prevent men belonging to all classes from entering these services, little remunerative as they are. Others take the risks of traveling in the deserts of Africa or wintering in the polar regions, of being eaten by lions or frozen to death, of falling from a Swiss mountain or foundering in a yacht, in preference to a life of tranquillity; and sportsmen elect the danger of endeavoring to kill an animal that can and may kill them, to shooting tame pheasants at a *battue* or partridges in a turnip-field. Then, in what is euphemistically called a life of peace, buyer and seller, master and servant, landlord and tenant, debtor and creditor, are all in a state of simmering antagonism; and the inventions and so-called improvements of applied science and art do not lessen it. Exercise is antagonism; at each step force is used to lift up our bodies and push back the earth; as the eminent Joseph Montgolfier said, that when he saw a company dancing, he mentally inverted his view and imagined the earth dancing on the dancers' feet, which it most unquestionably did. Indeed, his great invention of balloons was guessed at by his witnessing a mild form of antagonism between heat and gravitation. He, being a dutiful husband, was airing his wife's dresses, who was going to a ball. He observed the hot air from the fire inflated the light materials, which rose up in a sort of spheroidal form (you may have some of you noticed this form in dress!). This gave him the idea of the fire-balloon, which, being a large paper-maker at Annonay, he forthwith experimented on, and hence we got aërial navigation. This anecdote was told me by his nephew M. Seguin, also an eminent man. Even what we call a natural death is a greater struggle than that which other animals go through, and is, in fact, the most artificial of all deaths. The lower animals, practically speaking, do experience a natural death, i. e., a violent or unforeseen death. As soon as their powers decline to such an extent that they can not take part in the struggle for existence, they die or are killed, generally quickly, and their sufferings are not protracted by the artificial tortures arising from the endeavors to prolong life.

Let us now pass from individuals to communities. Is there less antagonism now than of yore? Do the nations of Europe now form a happy family? Are the armaments of Continental nations, or is the navy of this country, less than in former years? The very expression "the great powers" involves antagonism. As with wars and revolutions, so, as I have said, with regard to individuals, during our so-called peace, the fight is continuous among communities. If the water does not boil, it simmers. Not

merely are there the struggles of poor against rich going on, but the battles for position and pre-eminence are constant. The subjugated party or sect seeks first for toleration, then for equalization, and then for domination. We call contentment a virtue, but we inculcate discontent. A father reproaches his son for not exerting himself to improve his position, and at school and college and in subsequent periods of life efforts at advancement in the social scale are recommended. Individual antagonisms, class antagonisms, political, trading, and religious antagonisms take the place of war. Can war exhibit a more vigorous and persistent antagonism than competition does? Take the college student with ruined health; take the bankrupt tradesman with ruined family; take the aspirants to fashion turning night into day, and preferring gas or electric light to that of the sun. But our very amusements are of a combative character: chess, whist, billiards, racing, cricket, foot-ball, etc. And in all these we, in common parlance, speak of *beating* our opponent. Even dancing is probably a relic and reminiscence of war, and some of its forms are of a military character. I can call to mind only one game which is not combative, and that is the game you are in some sort now playing, viz., "patience," and with, I fear, some degree of internal antagonism!

Take, again, the ordinary incidents of a day's life in London. Fifteen to twenty thousand cabs, omnibuses, vans, private carriages, etc., all struggling, the horses pushing the earth back and themselves forward, the pedestrians doing the same, but the horses compulsorily—they have not as yet got votes. The occupants of the cabs, vans, etc., are supposed to act from free will, but in the majority of cases they are as much driven as the horses. Insolvents trying to renew bills, rich men trying to save what they have got by saving half an hour of time. Imagine, if you can, the friction of all this, and add the bargaining in shops, the mental efforts in counting-houses, banks, etc., and road-repair, now a permanent and continuous institution. Take our railways: similar efforts and resistances. Drivers, signal-men, porters, etc., and the force emanating from the sun millions of years ago, and locked up in the coal-fields, as Stephenson suggested, now employed to overcome the inertia of trains and to make them push the earth in this or that direction, and themselves along its surface. Take the daily struggles in commerce, law, professions, and legislation, and sometimes even in science and literature. Politics I can not enter upon here, but must leave you to judge whether there is not some degree of antagonism in this pursuit. In all this there is plenty of useful antagonism, plenty of useless—much to please Ormuzd and much to delight Ahriman; but of the two extremes, overwork or stagnation, the latter would, I think, do Ahriman's work more

efficiently than the former. We cry peace when there is no peace. Would the world, however, be better if it were otherwise? Is the Nirvana a pleasing prospect? Sleep, though not without its troubles and internal antagonism, is our nearest approach to it, but we should hardly wish to be always asleep.

Shakespeare not only knew something about gravitation, but he also knew something about antagonism. He says, by the mouth of Agamemnon:

> "Sith every action that hath gone before
> Whereof we have record, trial did draw
> Bias and thwart, not answering the aim,
> And that unbodied figure of the thought
> That gav't surmised shape."

In no case is the friction of life shown more than in the performance of "duty," i. e., an act of self-resistance, a word very commonly used; but the realization of it is by no means so frequent. Indeed, faith in its performance so yields to skepticism that it is said that, when a man talks of doing his duty, he is meditating some knavish trick.

The words good and evil are correlative: they are like height and depth, parent and offspring. You can not, as far as I can see, conceive the existence of the one without involving the conception of the other. In their common acceptation they represent the antagonism between what is agreeable or beneficial and what is painful or injurious. An old anecdote will give us the notion of good and evil in a slenderly educated mind. A missionary having considered that he had successfully inculcated good principles in the mind of a previously untutored savage, produced him for exhibition before a select audience, and began his catechism by asking him the nature of good and evil. "Evil," the pupil answered, "is when other man takes my wife." "Right," said the missionary, "now give me an example of good." The answer was, "Good is when me takes other man's wife." The answer was not exactly what was expected, but was not far in disaccord with modern views among ourselves and other so-called civilized races. I don't mean as to running away with other men's wives! But we still view good and evil very much as affecting our own interests. At the commencement of a war each of the opposing parties view victory—i. e., the destruction of their enemies—as good, and being vanquished as evil. Congregations pray for this. Statesmen invoke the god of battles. Those among you who are old enough will call to mind the Crimean War. Each combatant nation gives thanks for the destruction of the enemy, each side possibly believing that they respectively are in the right, but in reality not troubling themselves much about that minor question. We (un-

consciously perhaps) "compound for sins we are inclined to by damning those we have no mind to." So in the daily life of what is called peace. The stage-coach proprietor rejoiced when he had driven his rival off the road, railway directors and shareholders now do the same, so do publicans, shopkeepers, and other rivals. We are still permeated by the old notion of good and evil. But "antagonism," as I view it, not only comprehends the relation of good and evil, but, as I have said, produces both, and is as necessary to good as to evil. Without it there would be neither good nor evil. Judging of the lives of our progenitors from what we see of the present races of men of less cerebral development, we may characterize them as having been more impulsive than ourselves, and as having their joys and sorrows more quickly alternated. After the hunt for food, accompanied by privation and suffering, comes the feast to gorging. Their main evil was starvation, their good repletion. Even now the Esquimau watches a seal-hole in the bitter cold for hours and days, and his compensation is the spearing and eating the seal. The good is resultant upon and in the long run I suppose equivalent to the evil. These men look not back into the past, and forward into the future, as we do. We, by extending our thought over a wider area, are led to more continuing sacrifices, and aim at more lasting enjoyment in the result. The child suffers at school in order that his future life may be more prosperous. The man spends the best part of his life in arduous toil, physical or mental, in order that he may not want in his later years, or that his family may reap the benefit of his labor. Further-seeing men spend their whole lives on work little remunerative that succeeding generations may be benefited. The prudent man transmits health and wealth to his descendants, the improvident man poverty or gout. One main element of what we call civilization is the capability of looking further back into the past, and further forward into the future; but, though measured on a different scale, the average antagonism and approximate equivalence appear to me to be the same.

Can we suppose a state of things either in the inorganic or the organic world which, consistently with our experience or any deduction drawn from it, would be without antagonism. In the inorganic world it would be the absence of all movement, or, what practically amounts to the same thing, movement of everything in the same direction, and the same relative velocity; for, as movement is only known to us by relation, movement where nothing is stationary or moving in a different direction, or with a different velocity, would be unrecognizable. So in the organic but non-sentient world, if there were no struggle, no absorption of food, no growth, nothing to overcome, there would be nothing to call life. If, again, in the sentient world there were no appetites, no hopes

—for both these involve discontent—no fear, no good or bad, what would life be? If fully carried out, is not a life without antagonism no life at all, a barren metaphysical conception of existence, or rather alleged conception, for we can not present to the mind the form of such conception? In the most ordinary actions, such as are necessary to sustain existence, we find, as I have already pointed out, a struggle more or less intense, but we also find a reciprocal interdependence of effort and result. The graminivorous animal is, during his waking hours, always at work, always making a small but continuous effort, selecting his pastures, cropping vegetables, avoiding enemies, etc. The carnivora suffer more in their normal existence; their hunger is greater, and their physical exertion, when they are driven by hunger to make efforts to obtain food, is more violent than with the herbivora if they capture their prey by speed or battle, or their mental efforts are greater if they capture it by craft. But then their gratification is also more intense, and thus there is a sort of rough equation between their pain and their pleasure: the more sustained the labor, the more permanent is the gratification. As with food or exercise, deficiency is as injurious in one as is excess in another direction; so, as affecting the mind of communities, as I have stated it to be with individuals, the effect of a life of ease and too much repose is as much to be avoided as a life of unremitting toil. The Pitcairn-Islanders, who managed in some way to adapt their wants to their supply and to avoid undue increase of population, are said never to have reached old age. In consequence of the uneventful, unexcited lives they led, they died of inaction, not from deficiency of food or shelter, but of excitement. They should have migrated to England! They died as hares do when their ears are stuffed with cotton, i. e., from want of anxiety. We have hope in our suffering, and in the mid-gush of our pleasures something bitter surges up:

> "We look before and after, and pine for what is not,
> Our sincerest laughter with some pain is fraught,
> Our sweetest songs are those which tell of saddest thought."

The question may possibly occur to you, Have we more or less antagonism now than in former times? We certainly have more complexity, more differentiation, in our mental characteristics, and probably in our physical, so far as the structure of the brain is concerned; but is there less antagonism? With greater complexity come increased wants, more continuous cares. Higher cerebral development is accompanied with greater nervous irritability, with greater social intricacies—we have more frequent petty annoyances, and they affect us more. With all our so-called social improvements, is there not the same struggle between crime

and its repression? If we have no longer highway robberies, how many more cases of fraud exist, most of it not touched by our criminal laws! As to litigation, I am perhaps not an impartial judge, but it seems to me that, if law were as cheap as it is desired, every next-door neighbor would be in litigation. It would seem as if social order had never more than the turn of the scale which is necessary to social existence in its favor when contrasted with the disorganizing forces. Without that there would be perpetual insurrections and anarchy. But though antagonism takes a different form, it is still there. Are wars more regulated by justice than of yore? I venture to doubt it, though probably many may disagree with me. National self-interest or self-aggrandizement is, I think, the predominant factor, and is frequently admittedly so. I also doubt if the old maxim, "If you wish for peace, prepare for war," is of much value. Large armaments and improvements in the means of destruction (whose inventors are more thought of than the discoverers of natural truths) are as frequently the cause of war as of its prevention. Are wars less sanguinary with 100-ton guns than with bows and arrows? I can not enter into statistics on this subject, but a sensible writer who has, viz., Mr. Finlaison, came to the conclusion that wars cease now as anciently, not in the ratio of the improvements in killing implements, but from exhaustion of men or means. Wars undoubtedly occur at more distant intervals, or the human race would become extinct. Probably the largely increased competition supplies their place: we fight commercially more and militarily less. It is a sad reflection that man is almost the only animal that fights, not for food or means of life or of perpetuating its race, but from motives of the merest vanity, ambition, or passion. War is, however, not wholly evil. It develops noble qualities—courage, endurance, self-sacrifice, friendship, etc.—and tends to get rid of the silly incumbrances of fashion and ostentation. But do the much-bepraised inventions of peace bring less antagonism? Consider the enormous labor and waste of time due to competition in the advertising system alone. Paper-making, type-founding, printing, pasting, posting or otherwise circulating, sandwich-men, etc., all at work for purposes which I venture to think are in great part useless; and those who might add to the productiveness of the earth, or to the enriching our knowledge, are helping to extend the limits of the black country, and wasting their time in interested self-laudation. And the consumer pays the costs. "Buy my clothing, which will never wear out." "Become a shareholder in our company, which will pay cent per cent." "Take my pills, which will cure all diseases," etc. These eulogies come from those highly impartial persons the advertisers, all promising golden rewards, but, as with the alchemists, on condition that gold be paid in ad-

vance for their wares; and the silly portion of the public, no small body, take them at their word. Though you may not fully agree in this my anathema of the advertising system, and though there may be some small modicum of good in it, I think you will agree that it affords a notable illustration of antagonism. If I were a younger man, I think I should go to Kamchatka to avoid the penny post; possibly I should not be satisfied when I got there. Civilization begins by supplying wants, and ends by creating them; and each supply for the newly created want begets other wants, and so on, "*toties quoties.*"

As far as we can judge by its present progress, mankind seems tending to an automatic state. The requirements of each day are becoming so numerous as to occupy the greater portion of that day; and when telegrams, telephones, electro-motion, and numerous other innovations which will probably follow these, reach their full development, no time will be left for thought, repose, or any spontaneous individual action. In this mechanical state of existence, in times of peace, extremes of joy and sorrow, of good and evil, will become more rare, and the necessary uniformity of life will reduce passion and feeling to a continuous petty friction. The converse of the existence contemplated by the Stoics will be attained, and, instead of a life of calm contemplation, our successors will have a life of objectless activity. The end will be swallowed up in the means. It will be all pursuit and no attainment. Is there a *juste milieu*, a point at which the superfluous *commoda vitæ* will cease? None probably would agree at where that point should be fixed, and the future alone can show whether the human race will emancipate itself from being, like Frankenstein, the slave of the monster it has created. In the cases I have given as illustrations—and many more might be adduced—the evil resulting from apparently beneficial changes is not a mere accident: it is as necessary a consequence as reaction is a consequence of action. In the struggle for existence or supremacy, inevitable in all social growths, the invention, enactment, etc., intended to remedy an assumed evil, will be taken advantage of by those for whom it is not intended; the real grievance will be exaggerated by those having an interest in trading on it, and the remedy itself will have collateral results not contemplated by those who introduce the change. I could give many instances of this by my own experience as an advocate and judge, but this would lead me away from my subject. Evils, indeed, result from the very change of habit induced by the alleged improvement. The carriage which saves fatigue induces listlessness, and tends to prevent healthy exercise. The knife and fork save the labor of mastication, but by their use there is not the same stimulus to the salivary glands, not the full healthy amount of secretion, whereby digestion suf-

fers; there is not the same exercise of the teeth whereby they are strengthened and uniformly worn, as we see in ancient skulls. It seems not improbable that their premature decay in civilized nations is due to the want of their normal exercise by the substitution of the knife and fork and stew-pan. According to the evolution theory, our organs have grown into what they are, or ought to be, by long use, and the remission of this tends to irregular development, or atrophy. Every artificial appliance renders nugatory some pre-existing mode of action, either voluntary or involuntary; and as the parts of the whole organism have become correlated, each part being modified by the functions and actions of the others, every part suffers more or less when the mode of action of any one part is changed. So with the social structure, the same correlation of its constituent parts is a necessary consequence of its growth, and the change of one part affects the well-being of other parts. All change, to be healthy, must be extremely slow, the defect struggling with the remedy through countless but infinitesimally minute gradations.

Lastly, do the forms of government give us any firm ground to rest upon as to there being less undue antagonism in one than in another form? Whether it is better to run a risk of, say, one chance in a thousand or more of being decapitated unjustly by a despot, or to have what one may eat or drink, or whom one may marry, decided by a majority of parish voters, is a question on which opinions may differ, but there is abundant antagonism in either case. Communism, the dream of enthusiasts, offers little prospect of ease. It involves an unstable equilibrium, i. e., it consists of a chain of connection where a defect in one link can destroy the working of the whole system, and why the executive in that system should be more perfect than in others I never have been able to see. Antagonism, on the other hand, tends to stability. Each man working for his own interests helps to supply the wants of others, thus ministering to public convenience and order, and if one or more fail the general weal is not imperiled.

You may ask, Why this universal antagonism? My answer is, I don't know; science deals only with the how, not with the why. Why does matter gravitate to other matter with a force inversely as the square of the distance? Why does oxygen unite with hydrogen? All that I can say is, that antagonism is to my mind universal, and will, I believe, some day be considered as much a law as the law of gravitation. If matter is, as we believe, everywhere, even in the interplanetary spaces, and if it attracts and moves other matter, which it apparently must do, there must be friction or antagonism of some kind. So with organized beings, Nature only recognizes the right, or rather the power, of the

strongest. If twenty men be wrecked on a secluded island which will only support ten, which ten have a right to the produce of the island? Nature gives no voice, and the strongest take it. You may further ask me, *Cui bono?* what is the use of this disquisition? I should answer, If the views be true, it is always useful to know the truth. The greatest discoveries have appeared useless at the time. Kepler's discovery of the relations of the planetary movements appeared of no use at the time; no one would now pronounce it useless. I can, however, see much probable utility in the doctrine I have advocated. The conviction of the necessity of antagonism, and that without it there would be no light, heat, electricity, or life, may teach us (assuming free will) to measure effort by the probable result and to estimate the degree of probability. It may teach us not to waste our powers on fruitless objects, but to utilize and regulate this necessity of existence; for, if my views are correct, too much or too little is bad, and a due proportion is good (like many other useful things, it is best in moderation), to accept it rather as a boon than a bane, and to know that we can not do good without effort—that is, without some suffering.

I have spoken of antagonism as pervading the universe. Is there, you may ask, any limit in point of time or space to force? If there be so, there must be a limit to antagonism. It is said that heat tends to dissipate itself, and all things necessarily to acquire a uniform temperature. This would in time tend practically, though not absolutely, to the annihilation of force and to universal death; but if there be evidence of this in our solar system and what we know of some parts of the universe, which probably is but little, is there no conceivable means of reaction or regeneration of active heat? There is some evidence of a probable zero of temperature for gases as we know them, i. e., a temperature so low that at it matter could not exist in a gaseous form; but passing over gases and liquids, if matter becomes solid by loss of heat, such solid matter would coalesce, masses would be formed, these would gravitate to each other and come into collision. It would be the nebular hypothesis over again. Condensation and collisions would again generate heat; and so on *ad infinitum*.

Collisions in the visible universe are probably more frequent than is usually supposed. New nebulæ appear where there were none before, as recently in the constellation of Andromeda. Mr. Lockyer, as I have said, considers that they are constant in the nebulæ; and if there be such a number of meteorites as are stated to fall daily into the atmosphere of this insignificant planet, what numbers must there be in the universe? There must be a sort of fog of meteorites, and this may account, coupled with possibly some dissipation of light or change of it into other forces, for the smaller

degree of light than would be expected if the universe of stellar bodies were infinite. For if so, and the stars are assumed to be of an equal average brightness, then if no loss or obstruction, as light decreases as the square of the distance and stars increase in the same ratio, the night would be as brightly illuminated as the day. We are told that there are stars of different ages—nascent, adolescent, mature, decaying, and dying; and when some of them, like nations at war, are broken up by collision into fragments or resolved into vapor, the particles fight as individuals do, and, like them, end by coalescing and forming new suns and planets. As the comparatively few people who die in London to-night do not affect us here, so in the visible universe one sun or planet in a billion or more may die every century and not be missed, while another is being slowly born out of a nebula. Thus worlds may be regenerated by antagonism without having for the time more effect upon the Cosmos than the people now dying in London have upon us. I do not venture to say that these collisions are in themselves sufficient to renew solar life; time may give us more information. There may be other modes of regeneration or renewed activity of the dissipated force, and some of a molecular character. The conversion of heat into atomic force has been suggested by Mr. Crookes. I give no opinion on that, but I humbly venture to doubt the mortality of the universe.

Again, is the universe limited? and if so, by what? Not, I presume, by a stone wall! or, if so, where does the wall end? Is space limited, and how? If space be unlimited and the universe of suns, planets, etc., limited, then the visible universe becomes a luminous speck in an infinity of dark, vacuous space, and the gases, or at all events the so-called ether, unless limited in elasticity, would expand into this vacuum—a limited quantity of ether into an infinite vacuum! If the universe of matter be unlimited in space, then the cooling down may be unlimited in time. But these are perhaps fruitless speculations. We can not comprehend infinity, neither can we conceive a limitation to it. I must once more quote Shakespeare, and say in his words, "It is past the infinite of thought." But whatever be the case with some stars and planets, I can not bring myself to believe in a dead universe surrounded by a dark ocean of frozen ether. Most of you have read "Wonderland," and may recollect that after the Duchess has uttered some ponderous and enigmatical apothegms, Alice says, "Oh!" "Ah," says the Duchess, "I could say a good deal more if I chose." So could I; but my relentless antagonist opposite (the clock) warns me, and I will only add one more word, which you will be glad to hear, and that word is—Finis.—*Nature.*

MENTAL TRAITS IN THE POULTRY-YARD.

By BENJAMIN KARR.

THE instincts and ordinary habits of the common barn-yard fowl have been closely studied and exhaustively discussed, but it is otherwise with the almost human emotions and mental processes which are sometimes to be observed in the poultry-yard. The mere searcher for knowledge will discover them with difficulty, but they are easily found by an eye which sees with the long familiarity of companionship. Many summers of fond intimacy with the poultry of a western New York farm long ago convinced at least two boys of this fact. Living in Buffalo, the writer and a brother, who was an inseparable companion, boarded through the whole or a part of several seasons, sometimes six months together, on a farm in Orleans County. Our time was entirely our own, and, as we found little companionship among the busy country lads, many days might have hung heavily on our hands had we not been wholly content to spend the greater part of them among the chickens and the turkeys; only one season, we added ducks. Our parents had taught us to love and observe Nature, and we were well read for our years in natural history. What was of more importance, we had been led from early childhood to be exact and painstaking in all things. Our play with toys was tiresome to most boys by reason of its carefulness. Under such circumstances it will not, perhaps, be thought strange that either of us could tell every fowl, young or old, toward the end of each summer, by its name and nearly all of them by their cackling. Usually there were about one hundred on the premises. We not only knew their general appearance as we would familiar faces, but I think there is no doubt that a glimpse of even the half of any head in the barn-yard would have been enough for instant recognition. We knew every hen's nest, when the egg-yield was two dozen a day, and my brother could promptly and with certainty sort out ten dozen eggs and tell which hen laid every one. When there were twenty half-grown cockerels on the farm we could readily name any one which crowed out of sight. Poultry, hens as well as their more pugnacious lords, always keep a well-defined scale of authority in force. Not one out of fifty is ignorant of its superiors and inferiors. A brood of young chickens will often settle all this business, while yet little more than fuzzy balls, by a series of really cruel fights. We never missed these exhibitions of infantile ferocity if we could help it, and a particularly savage young fighter was immediately a marked object of our admiring interest. He was usually given

a long name out of the copious vocabulary of our chicken dialect, a form of speech which always amazed those who chanced to overhear it. We counted it one of the least of our duties to keep accurately informed concerning all changes of rank, and to know at any time just how many others every fowl on the farm could "boss," and how many, in turn, "bossed" it. From the old sultan, who acknowledged no rivals, to the forlorn "scrub" of the youngest brood of chicks which had fought out their station, there were no exceptions. These facts, which might easily be multiplied, will suffice to account for the exceptional observations of our long experience as poultry-lovers.

We early learned that our pets had striking individuality. In this broad fact we found ample reason to note with interest rather than surprise the after-discoveries of almost human traits which made them a never-ending delight. There were young roosters all fuss and bluster from the first, while others were singularly quiet and wary, just as some hens were solitary and suspicious, and others were trustful in the extreme and wretched without much company. These traits were not only inherited, but could be discerned very early. Two or three of the bravest hens on the farm would always, after "stealing a nest," with our permission, bring out a brood of young fighters as much like their mother in habits as in appearance. We could only guess at the descent in the male line. In one case of this kind, where a fine hen was left with but a single chick after the casualties of the first few days, we managed to make the little fellow so conceited and pugnacious that he would fight chickens twice his size, and more than once before he was weaned he tried to whip his mother. This we did by throwing food to a larger chicken, beginning with one which we knew to be cowardly, in such a way that it would get the morsel while its tail was turned toward our little champion. Immediately another tidbit, dropped in front of the victim, would make it appear to be running away at the very time that it was getting all the food the other wanted. He soon showed his disgust by pecking the retreating form of the hungry chicken, and we never let the object of his wrath turn until he was very sure that it was afraid of him; then, if it showed too much pluck, we could always tempt or drive it away in time to make our little pet think it was really conquered. The tiny victor was as proud as if he had been four times as big, and got his fill to eat as his reward. By a long course of this sort of training his audacity became only less remarkable than his courage and fierceness in fighting. With other young roosters, until they were nearly half-grown, the same tactics usually succeeded in bringing on a fight. Often we started a "feed" with one, the confident master, and the other, the uneasy but intimidated subject, and ended it with the

positions reversed, after a bloody struggle. In this test the difference in disposition was exactly what it would have been in human beings under like conditions. Some were eager to venture a peck at the apparently yielding tyrant, and would quickly jump at the conclusion that he was overthrown. But the confidence with which a cockerel of this sort chased his indignant but hungry master was only exceeded by the briefness of his resistance when the outraged victim of our tricks was allowed to turn and fight. Young roosters of another stamp could only rarely be deceived into mistaking the movements of a superior in rank, but when, after long and careful manœuvring, in which the one of us whose business it was to keep away a swarm of hungry spectators generally grew very tired, the subject did conclude that he had somehow changed places with his former tyrant, there was a fierce fight, and the rebel often won. It was the old story of the terrors of pugnacity, hard to arouse, and the strength of purposes slowly formed.

It is in fighting that some of the most curious traits are manifested by fowls of all kinds. Notice the coops of Cochins and brahmas in a poultry-show, and you will find many of the cocks with combs bloody and scarred from pecking one another's heads. They thrust their necks out between the side of the coop and the first slat in front and clumsily punish each other. In long rows of coops of games, placed in exactly the same way, not a peck is given. It is not that the slow and easily whipped Asiatics are fonder of fighting than the ideal gladiators of the animal world, but simply that no game-cock will put himself at a disadvantage by getting his head in reach first. When game-cocks look out, it is through one of the middle spaces. Fighting is too serious a business with these high-spirited birds to be mixed with foolishness. Other breeds than games, however, occasionally produce natural fighters that show remarkable cunning. A light and graceful young dominique, one of the proudest and most intelligent of our pets, belonged to a neighbor, but was very fond of coming over to a barn-yard which was about as near his home as the house where we boarded. He was very reluctant to endure punishment in fights, but he was also loath to retreat before any antagonist, and dearly loved to have us feed him and "bide and doctor wi' 'im," as the Devonshire farm-hand put it. The consequence was, that he would try a round with any foe, and if he found himself overmatched he generally managed to retreat with a brave show of fight and get off without much loss of blood or prestige. One day he was attacked by a turkey, and at the very beginning of the combat he happened to light on its back. No descendant of the race which lived, in a wild state, in terror of the downward swoop of the great horned owl, can bear to be attacked from

above, and the turkey cried for quarter at once. The lesson of the easy victory was not lost, and thenceforth the young cock fought turkeys with evident relish, always managing to reach their backs, and so routing them with ease and celerity. Our best rooster, however, was too strong and heavy to suit him, and encounters with this hard fighter were very unwelcome. While one of us fed the visitor, the other would catch the home champion, and by taking him around to the farther side of the barn let him enter the barn-yard on the trespasser's line of retreat. Of course, there would be a fight, and it was difficult for the jaunty intruder to make his escape in good order without many severe knocks. After a time he always kept a sharp watch on the dangerous corner of the barn-yard, and at any suspicious noise in that quarter he started for home in great excitement. At last he almost entirely ceased to visit us. In the cellar of a house in Buffalo, where a number of chickens and two or three turkeys which had been brought up from a farm on Grand Island were kept until wanted for the table, I once saw a young black Spanish cock fight and win a bloody battle with a very large gobbler. The turkey tried to escape his vindictive conqueror by taking refuge upon a board partition at least four feet high, between two empty coal-bins. There he stood and stretched his long neck out as far as possible. The victor flew up beside him and tried in vain to reach his head. Then he wasted a few savage pecks upon the gobbler's heavy wing, and gave that up in disgust. At last he appeared to study out a plan, and deliberately flew straight for the turkey's head, seized it with his beak, and hung on as long as possible. Then, dropping to the ground, he contentedly mounted again to the side of his terrified victim and repeated the punishment. This he did the third time, with perfect system, and would have gone on indefinitely had I not interfered to save the wretched bird. An Indian could not have taken more delight in torturing a vanquished foe. The most remarkable exhibition of cunning in cock-fights, however, that came under my observation, was witnessed in the barn-yard of a farm adjoining our Orleans County headquarters. There were three old roosters on the place, and they had divided up the territory instead of holding each one a certain rank in all of it. The cow-stable and a corner of the barn-yard adjacent belonged to a big clumsy partridge Cochin, the horse-stable and the grain-barn to a cock more black Spanish than anything else, and the end of the barn-yard farthest from the stables, with the house door-yard, to a white Leghorn. There were neutral zones, as the diplomats say, between every two divisions, and these were the scene of some sharp fighting and a great deal of crowing and hostile manœuvring. One day the Cochin and the white Leghorn met in the barn-yard, and

the latter began his usual tactics of worrying his enemy, taking precious care of himself all the time. He was never fond of hard hitting, but trusted mainly to trickery. The big Cochin would stretch his neck up, now and then, and thunder out a ponderous challenge, and every time the agile Leghorn made a quick rush, sometimes going six feet, and knocked the helpless Asiatic nearly or quite off his feet before he could stop crowing or lower his head. When the victim recovered, his foe was invariably out of reach. At last the white rooster was given a taste of his own clever tactics. He had been crowing freely with impunity all the time, but suddenly, as he began another shrill taunt, he was startled by a rush like his own and knocked over before he could get into position for defense. After that the Cochin never missed a chance to use this artifice in fighting, with other cocks as well as the white Leghorn. He had acquired skill as truly as any general ever did.

An amusing test of the difference of disposition in barn-yard fowls may be made by placing a piece of looking-glass against the trunk of a large tree, and laying a train of corn in front of it. Some hens will discover what they all take for a new arrival with mild curiosity and merely look at it intently, perhaps peering around behind the tree, and then walk quietly away. Others peck the glass angrily and insist upon fighting, while a few nervous females show much the same noisy excitement that seizes upon most hens when they spy a snake. We tried the valiant old autocrat of the farm-yard with this trick, and he was at once roused to fury. Dropping his head when some ten feet in front of the glass, he began the cautious advance by parallels, which every one familiar with poultry has seen before a fight. But, of course, he soon lost his enemy by moving too far to one side. After crowing fiercely and looking around uneasily for a few moments, he returned to the train of corn, and almost instantly saw the strange cock nearer than before. More stealthy approach, another failure to keep sight of the foe, and greater excitement, and a third time he began to eat, only to be startled by the hostile presence nearer than ever. At last he worked right up to the glass and braced himself for the shock of combat, the counterfeit, of course, following his every movement with ominous celerity. There was one fierce peck at the angry head in the glass, and then a crash, as our infuriated champion hurled himself against his likeness, breaking the glass into a hundred fragments. The mingling of astonishment, rage, and triumph in this bird's appearance, as he whirled about, startled at the cracking noise, and bewildered by the total disappearance of his enemy, was comical to behold. Then he rushed around behind the big pear-tree, evidently thinking that the cowardly stranger might be

hidden there. Not finding him, the victor strutted about, too excited to eat, and crowed long and loud over his unprecedented triumph. The other cock was entirely wiped out of existence, and our old fighter, who would crow defiantly in our arms whenever he found himself being carried off the premises, knowing from experience that a set-to was coming, could scarcely credit his senses.

Of the many feelings which human beings and poultry have in common, one is the sense of mortification. On a fine summer morning a group of cockerels, of various ages, were lounging about in the door-yard, when they began a crowing tournament. Some of the smallest and most humble stood contentedly on the ground, but soon one flew upon the carriage-step and crowed from that elevation. He was promptly eclipsed by another, who gave vent to an exultant challenge from the top of the hitching-post. Then the proudest and handsomest of them all walked a few steps with an air of conscious superiority, and flew straight up to the highest bar of the reel of a reaper near by. It was a simple reel of light horizontal bars, not connected with the rake, and revolved very easily. While the young dandy's wings were still flapping in triumph and he had not yet begun to crow, the reel turned under his weight and lowered him swiftly to the ground. Without a sound the crestfallen rooster walked away, too ashamed to look around. We often enjoyed a still more amusing exhibition of this sort on the part of the proudest old cock on the place. He was a very gallant Mormon, and intensely self-conscious when among the hens; but if coaxed off by himself, on a side of the house where no other fowl was in sight, he could be easily frightened out of his dignity. A hat thrown at him would send him squawking around the corner of the building, his plumage disarranged, and his whole appearance eloquent of blind terror. We always managed it that he should run straight into a group of hens, and the desperate haste with which he choked down his wild cackling and began to murmur amorous nothings to the ladies of his harem was only less ridiculous than the instant change in his whole appearance, which became that of a pompous and leisurely sultan. He generally overacted a little, making an extra display of his careless gallantry and elegance to show how absurd it was to suspect that he could have been in the least alarmed. A laughable instance of similar mortification in the biggest turkey on the farm was noticed one late autumn day, when this great gobbler and numerous others, much younger and smaller, were eating grass and strutting in the door-yard. Just as the old gobbler spread his tail for a tremendous strut, a young turkey stepped quickly up behind him and pecked sharply at the small spot of skin exposed in the center of the big fellow's

great fan of feathers. It was evidently done through a mistaken notion of the object tested, but it hurt the victim's pride terribly to have such liberty taken with his person. Down came his tail, and he walked off in injured dignity, conscious that he had been involved in something ridiculous.

A disappointed barn-yard fowl is often as cross as if it could show its temper after the manner of human beings. The big dominique rooster that smashed the looking-glass was a very good-natured fellow with hens and young chickens, and he seldom resented having kernels of corn, no matter how many, snatched out from under his beak, when it was done in a fair scramble. But if he had begun to crow, and a kernel was unexpectedly dropped where he certainly would have got it, had he not been so busy, it was too much to see his share taken away by any other fowl. He frequently pecked the offender as soon as he could stop crowing, and showed general ill-temper for a few moments. His indignation was so amusing, that we fell into the habit of teasing him in this way, until, at last, the old fellow began to practice choking down the rest of his crow when corn was thrown in front of him. Gradually he managed to stop more and more quickly, and in the end he would swallow his voice with a gulp, and snatch a bit of food as promptly as if he had not been crowing at all.

A half-brother of this rooster learned very quickly to crow for corn, once for every kernel. He used to stand before us and crow as regularly as clock-work, always stopping for his reward, and never expecting a second kernel until he had crowed again. When almost satisfied, he waited much longer between times, and at last walked contentedly away. A black hen once showed almost equal intelligence in learning, not how to get food but how to be relieved of some which she could not help carrying around on her feathers. In the barbarous eagerness of boys to bring about fights, we often daubed old hens that held high rank and had many discontented subjects, with mud or anything else which would disguise them. On one occasion we dyed a speckled cock red with carpet-dye, glued a stiff, high comb of paper on his frost-amputated stump, and tied up his wattles under his throat. This overdid the business to such an extent that the other roosters fled from him in horror, as if he had been a hawk, and the Devonshire farm-hand, looking at him in amazement, exclaimed, "Byes, what fresh bird have ye brought about here?" Mud failed on the black hen in question, and we tried common paste, never thinking of one result—it turned the poor hen's feathers back, like those of a frizzled fowl—and, after we had done our best to wash the paste off, she was still in a sad plight. Many of her inferiors whipped her badly, and at last she became broken in

spirit and made no resistance. Then the other hens began to eat the paste off her feathers, and the poor bird would deliberately walk up to her former subjects and stand patiently to be eaten clean. In time she recovered her beauty, but never her lost rank.

Nations, shorn of their prestige or territory in one quarter, often "seek compensation" in another, where their neighbors are weak; and brutes in human form, after being whipped in a drunken fight by other men, sometimes soothe their wounded pride by beating their wives at home. So it is with poultry. A cock, chased by one of higher rank, will often vent his spite upon the first half-grown cockerel that comes within his reach, and even bully hens around until he recovers from his own humiliation. From that allied weakness which makes men bluster most when in greatest fear, hens that are weak enough at other times, are savage toward young roosters, sure soon to become their masters. They chase them with noisy fury, and try in every way to intimidate them, carefully avoiding a trial of strength, however, as long as possible. When it comes, they collapse into shrieking submission, with laughable suddenness. When a hen simply ignores a young cockerel, he usually encounters much more serious resistance, and sometimes has to fight hard for victory.

Hens are harder to deceive, in some respects, than many women. They flock up to a rooster with eager freedom, when he is eating busily in silence, while they are very shy of heeding his most artful invitations to a feast, real or imaginary. When he eats they know there is something good, and that he is not thinking of entrapping them; but when he shakes his head up and down, picking up morsels in his beak and calling as a hen calls her chickens, they understand the amorous and deceitful ways of their lord too well to approach him rashly. Some cocks play comparatively few tricks, and they are much more trusted than others which are as insincere as seductive. Neither is the average fowl easily humbugged, on the other hand, by attempts to conceal a real feast. It is amusing to observe the calm, careless manner of a hen which has caught a mouse, as she walks off toward a secluded spot, making the same contented, nothing-to-do noise which is her ordinary note of idleness. This, of course, happens only when there is a chance that no other hen saw the mouse caught. But usually some quick-witted sister will at once "smell a mouse," and steal quietly up behind, not infrequently announcing her coming by snatching at the coveted dainty. The poultry-yard is always on the alert for a valuable discovery on the part of one of its inmates, and ready to put a sort of highway-robber socialism into practice at a moment's notice.

The foregoing plain statements of fact are but a few of the many proofs which the writer has seen of the existence in com-

mon barn-yard fowls of a degree of intelligence usually attributed only to much higher animals. Surely they show something far above the instincts familiar to all students of Nature. The sense of mortification in an individual has only a distant relationship to the rare instinct which makes chickens that were never out of the heart of a great city, and could not possibly have seen a more formidable bird than a pigeon, skurry for shelter when the far-off cry of the common hen-hawk is imitated in their presence. It is impossible for the bare narration of anecdotes to convey that certainty of intelligence and human emotions which early gave my brother and myself a sense of nearness to our farm-yard pets. We saw the countless little tricks of manner, the changes of expression, the indefinable consciousness which can never be appreciated save by those who, like ourselves, will literally live among unconfined and well-treated poultry. The purpose of this tribute will be served if it shall raise the reputation for intelligence of the barn-yard fowl, not indeed to the level of our belief, but somewhat above that on which the reader has heretofore placed it. The lesson is the oft-enforced truth that the greater part of what has been held by the majority of mankind to be exclusively human belongs only in less degree to the lower animals as well.

UNDERGROUND WATERS AND MINERAL VEINS.

By Prof. G. A. DAUBRÉE.

BEFORE occupying himself with the great masses that constitute the crust of the earth, and yielding to cupidity rather than to scientific curiosity, man attempted to discover the genesis of certain minerals. Have the middle ages not seen more than one alchemist, in his passionate search for the philosopher's stone, trying to discover the secret of Nature, and reproduce the processes by which she has created in the rocks gold, the most noble, as they said in those days, of the metals, and certainly the most precious?

According to the system of Thales, adopted by Aristotle, water was the universal principle of things. "If the elements are born of one another," wrote Seneca, "why may not the earth be produced from water? Like the human body, the earth includes a number of humors, some of which hardened when they came to maturity; whence the metallic earths, and stony substances, which are nothing but petrified liquids."

The hypotheses relative to the nature of mineral substances which were current down to the last century are related to this doctrine. Bernard Palissy, one of the most penetrative minds of his time, wrote: "All mineral matters that you call dead bodies

were also created as well as vegetable substances, and have been in travail to produce seeds from which others could be engendered. Crystal is not so dead but that it is given to it to know how to separate itself from other waters, and from itself, with its angles and diamond-points, in the midst of them. Thus, mineral matters are not so inert but they bring forth and gradually produce most excellent things. These mineral matters are intermingled and unrecognized among the waters, in the matrix of the earth, so that every human and brute creature is engendered under a kind of water. The matters of metals are concealed in such a way that it is impossible for man to distinguish them before they are congealed, just as no one can tell that water in which salt is dissolved is saline without tasting it with his tongue." Then, replying to the alchemists who had recourse in their experiments to the highest furnace-temperatures then known, Palissy added, "When you have tried everything by fire, you will find that my saying is true, that water is the beginning and origin of all natural things." One could not reason more ingeniously respecting an idea wholly of the imagination, but which could hardly have been sounder, at a time when, chemistry not having yet put on a scientific character, the nature of the substances whose origin it was sought to ascertain was still almost unknown.

Struck by the admirable regularity of the motions of the stars, a number of minds were led, by a mystical generalization, to draw from them consequences applicable to the phenomena of our planet. According to a doctrine that goes back to the Chaldeans, and is also found among the Egyptians, sidereal influences contribute to the maturing (that is, to the subterranean transformation) of mineral substances. Mysterious relations were supposed between the celestial bodies of our solar system and metals, the luster of which has some resemblance to the color of the stars. Conformably to the principle of likes, gold corresponded with the sun, silver with the moon, iron with Mars, copper with Venus, lead with Saturn, and tin with Jupiter. Strange as it may seem, this fancy had not been abandoned two centuries ago. An old German practical miner's manual, the "Bergbüchlein," the earliest known edition of which is dated in 1505, contains figures in which metalliferous veins may be seen running into the interior of the earth, and in the sky the planets which correspond respectively with the various metals, and from which the generative effluviæ are flowing. "With the birth and growth of a metallic mineral," it is said in the book, "are involved, on the one side an agent, and on the other a subordinate substance or matter, which is capable of being set into activity, like something in fermentation. The general agent is the sky, with its movements, the revolution of its planets, and its luminous radiation. This is why each metallic

mineral is subject to a special influence from its particular planet." Thus, in a little work of only a few pages, and which was simply intended to give the most necessary knowledge to the practical miner, was placed for the same consideration of utility as determines the employment of the compass, the notion of this pretended affinity between the metals and the planets.

The mode of formation, or, as Buffon said, the genesis of minerals is one of the most interesting questions of their history. But the problem could not be approached until geologists had furnished precise data on the conditions of their bearing. Satisfactory solutions have recently been obtained in the case of a certain number of mineral species. Synthetic experiment, placing itself in the circumstances that seem to have presided at their formation, has succeeded in reproducing them, with their crystalline forms, and all their essential characteristics, and has thus completed the demonstration of their origin. By means of this method of demonstration, we have been able to ascertain that many minerals are due to the action of subterranean waters. From the most ancient epochs, these waters have circulated through the crust of the earth, where they have left, at a multitude of points, signs revealing the part they have played, and the course they have taken, even more clearly than contemporary phenomena have done.

The sedimentary beds, formed like the deposits which the sea spreads every day in the bottom of its basin, are often distinguishable from one another, even at first sight, by certain exterior characters. The differences are, for the most part, produced by the action of subterranean waters, as is demonstrated by the animal and vegetable fossils, which were for a long time designated as petrifactions, or, rather, by the chemical changes which these fossilized bodies have evidently undergone.

Here, shells and corals, showing forms perfectly preserved down to their slightest details, are no longer composed of carbonate of lime, as they certainly were during the life of the animal to which they belonged, but are essentially different substances, quartz having entirely taken the place of the calcium carbonate. There are also other minerals, such as pyrites and sulphate of baryta, which have penetrated and crystallized within the cavities which the bodies of these invertebrates occupied.

The silicified woods, which are very frequently met, assert still more clearly the intervention of a liquid. Not only can the least trained eye recognize their external shape, but the ligneous texture also is still maintained, even to the cells and other inmost parts, as distinctly as in the living wood. It is not, then, a simple molding of silica, performed in the vacant spots that have been left by the disappearance of the vegetable substance, but the ef-

fect of a molecular substitution, gradual and slow, which has preserved to us the most delicate organs of various plants. A liquid, such as water, has been able of itself to produce these substitutions of one body for another, by depositing the substances which it held dissolved.

Changes due in like manner to an aqueous influence have induced the formation of the rounded bodies called nodules, which have been sometimes confounded with organic productions, although they are wholly mineral. Flint, which is a variety of quartz, often appears under a tubercular form. Nodules of it are found, in a parallel alignment to the structure of the chalk, in the chalk-beds of England and France. They have been produced subsequently to the deposition of the strata, and have often imbedded fossils upon which they have molded themselves. There are also calcareous nodules that have been produced in a similar manner. The most recent quaternary deposits, like the diluvian clay, or loess, present a large number of them. The same form appears very frequently in the carbonate of iron, which is particularly abundant in the clays of the coal-beds, and is mined in several counties of Great Britain. These balls may be recognized by their metallic luster and brassy color, and their surface spiked with crystalline points. They are formed of pyrites or bisulphuret of iron, and abound in the chalk, the plastic clay, and the carboniferous rocks. When, as the result of denudations, they appear isolated on the surface of rocks of an entirely different nature, people have sometimes been led to suppose them fallen from the sky; and so they have been given, in some parts of France, the vulgar names of thunder-stones or aërolithes. The substance which has been formed into these concretionary forms appears to have been subjected to the influence of a liquid vehicle, like quarry-water, or the water which has been imbibed by rocks. The tendency of dissolved matter to agglomerate, under the influence of attraction, into a spherical shape, has been opposed by the unequal resistance of the mass from which it isolates itself. Hence, the tubercular forms.

In the case of the blackish coatings called dendrites, the forms of which bear a deceptive resemblance to those of mosses, the deposit is wholly inorganic; water, branching out by capillary attraction through extremely minute cracks, has deposited oxide of manganese in them.

The marbles called veined give evidence of another mode of action of subterranean waters. Their varied aspect is due to little veins of white crystalline carbonate of lime winding around in a mass of dark color and amorphous character, but of the same chemical composition. Fissures, intersecting in every direction, are first produced in the rock, under the influence of mechanical

actions; the cavities thus opened have served as channels for waters which, on their passage, have dissolved a part of the substance to deposit it afterward purified by crystallization—a fact very much like what we habitually observe in our laboratories. This mode of veined structure is most frequent in the limestones of regions that have been dislocated. The Alps furnish many examples of it along escarpments of a considerable extent.

Modifications have also been imposed upon the eruptive rocks, under the influence of the waters that have traversed them; but they are of a different character from those that we have been considering, not only on account of the heat that has prevailed among them, but also on account of the composition of the rocks. Various mineral species, grouped under the name of *zeoliths*, may be observed among the eruptive rocks, as crystals adorning innumerable cavities, such as we may see produced in existing volcanic lavas, by the disengagement of the vapors which these lavas exhale down to the moment when they are completely solidified. It is easily seen that these *zeoliths* were not formed at the same time as the mother-rock, but after it had become consolidated and turgid. They always assume the same disposition, whatever the age of the rocks. Sometimes agate is associated with them, as at Oberstein, in the Palatinate, where that stone was mined in antiquity, and in Uruguay, where it is extracted at this time. Its concentric zones, laid one upon another in successive moldings, testify clearly to a gradual deposit, evidently of an aqueous nature. Waters of incrustation are producing under our eyes deposits of carbonate of lime of identical structure. The varied colorations of the successive zones of agate which are utilized in the making of cameos correspond with very slight variations in the nature of the precipitant liquid. The limpid crystals of Iceland-spar, to which physics is indebted, since Huygens, for most important discoveries in double refraction and the polarization of light, are associated with *zeoliths* in the cavities of ancient lavas, and originated at the same epoch.

We do not any longer have to resort to erroneous or vague conjectures to explain the origin of these minerals, for we have a demonstration, that might be called experimental, which throws the clearest light on all their details of it. The excavations made at Plombières in 1851, to increase the flow of the springs, brought to light in the deep trenches of the subsoil a part of the old Roman underground conduits that had escaped the ravages of the barbarians. They also disclosed a masonry-work of *béton* and bricks carefully built around the thermal springs, so as to isolate them from the neighboring river and the gravel, in which they were in danger of being scattered and cooled. Every spring imprisoned in this masonry, as it rose from its source, could only

escape, to flow on to the fish-ponds, through a vertical chimney of cut stone. Carefully examining the bricks which had been immersed for centuries in the mineral water, I discovered that they had undergone a transformation of the most interesting character. New combinations, silicates of the family of the zeolites, had been developed in the cavities with which the bricks were riddled; chabesite in striated crystals, grouped exactly like those in Nature, and with the same angles; and christianite, the crystals of which, intersecting one another in the form of a cross, are identical with those of the volcanic rocks. There was, besides, a product of opal, translucent and colored like drops of dew. The tissue of the bricks contained little fibrous and radiated globules, which optical characteristics showed to be chalcedony. The same species had been formed even in the minutest pores of the brick. These minerals, of contemporaneous production, were found later in the Roman masonry-works of Luxeuil and Bourbonne-les-Bains. With the aid of time, thermal water had there acted chemically on the bricks and on the limestone, and had engendered gradually and by a curious collaboration the substances we have named, without calling in the high temperature that we were ready to suppose was necessary, nor water very strongly mineralized. A very slow but incessant action was sufficient. Does not this demonstration, even to the minutest particulars, account for the formation in ancient epochs of zeolite, agate, and the substances that usually accompany them? In view of their complete similarity with those of which Plombières has revealed the history, can we not say that all these minerals were reproduced in rocks still incompletely cooled, by the chemical action of hot or lukewarm waters which infiltrated themselves into their easily permeable texture, and of which the parasitic zeolites accurately trace the ancient history?

On account of the multiplicity and extent of the works of exploitation that traverse the metalliferous beds in numerous countries, and the mathematical exactness with which all the details of their forms and composition are revealed every day, these beds bring to bear very precious data on the functions as mineralizers of the ancient springs. The veins of the most usual type have the form of plaques rarely exceeding a few metres in thickness. Horizontally, they are prolonged to considerable superficies, sometimes to ten or fifteen kilometres. This measurement is given by the extent to which workings have been promoted, and can be visibly exemplified on the surface of the ground, when the quartzose parts of the veins, persistent against denuding agencies, appear as steep ridges, of imposing height, which the eye can follow in the distance. Sometimes they stretch out like a gigantic wall irregularly notched, sometimes they rise in needles. In

depth, the veins are prolonged indefinitely, and mining excavations, however deeply they may be carried, fail to reach their lower limit.

At first sight, metalliferous veins contrast in their mineral composition with the incasing rocks, to whatever category they may belong, even when they are welded to them. They are formed of very different minerals; and it is necessary to distinguish in them the useful substances or minerals, and the stony matter or gangue. The last very often occur in a decidedly predominating proportion, and much that is unforeseen in the returns of a mining operation results from their variations in quantity and richness. The various substances constituting veins sometimes assume a symmetrical disposition in respect to the two walls, showing that they result from deposits made successively one upon another, as happens in a crystallizing pan or in fountain-pipes that are incrusted with stony substance.

Metalliferous veins are rarely isolated, but usually form systems or groups, connected by a bond of parallelism and by similarity of composition. They occur exclusively in regions that have suffered dislocations, of which they appear as if they were a consequence. The constitution of the soil of France well brings out this correlation. While veins are wanting in the districts in which the beds have nearly preserved their original horizontality, they are found by thousands, although of inferior richness, in the central plateau, the Vosges, the Pyrenees, and the Breton peninsula. They often border upon the eruptive rocks, with which they are visibly connected as if by a bond of relationship. Many countries famous for their metallic riches, like Cornwall, Hungary, and the State of Nevada, furnish striking examples of this last alliance.

Metalliferous veins betray their origin by their forms and the independent manner in which they cut rocks of every kind. Their formation is due to large vertical breaks, called faults, which have given an outlet to the substances and have ultimately been filled with them. The concomitance of the veins and of grand dislocations sufficiently testifies that metallic matters and their gangues have been brought from down up, that is, from the deeper regions of the globe toward the surface. From this fact, it was at first inferred that the ascension of the vein-filling minerals was accomplished by sublimation or at least by fusion, but this has been shown by many circumstances to be inexact. The specimens of the collections teach of themselves alone that their various minerals have been precipitated one after another, distributing themselves in an order quite different from their degree of fusibility and volatility. It should also be observed that the greater part of them are found outside of the veins, and in circumstances in

which they can not have been deposited except by the intermediary action of water.

These views, which the direct observation of Nature had suggested to Elie de Beaumont, have been experimentally verified by De Senarmont. Working with close tubes under pressure, and at a temperature very much higher than that of boiling water, this eminent observer succeeded in reproducing the minerals of the veins from the most common substances—quartz, sulphate of baryta, fluor-spar, iron and copper pyrites, blende, sulphuret of antimony, glance, spathic iron, and carbonate of zinc; all of which laboratory-minerals, in a crystallized condition, quite resembled the analogous natural minerals. The fact of the contemporaneous formation of many of these, as exemplified in the basins of existing springs, as at Bourbonne-les-Bains, come later to confirm and complete this demonstration. Deep fractures or faults, which so numerously furrow the crust of the earth, have therefore endured various destinies in the series of the ages. Some have remained empty, or have been filled only with fragments detached from their walls. Others have furnished a way of exit for fluid eruptive rocks, basalts and porphyries, for example; and, finally, there are those with which we are now concerned, which have served, by the intervention of water, as channels for metalliferous emanations.

These emanations have not been borne exclusively into faults. Sometimes they have filled interstices of irregular and various forms, thus constituting ore-bearing masses, now adjoining eruptive rocks, as if they had followed them, now incased in stratified beds. Whatever their forms, these masses are often in relation with faults which have served as vents for emanations, partly watery, from the interior of the earth.

Among the metalliferous deposits of the last category, some, still better than the veins, demonstrate the intervention of mineral or thermal waters. The masses of hydrated peroxide of iron, frequent at Berry, where the Romans mined for them, and in Périgord, Lorraine, Franche-Comté, and other districts, have been attributed, with much probability, to the presence of gaseous springs, in which iron was dissolved as a bicarbonate. The form of globules with concentric laminations, or pitholiths, which they affect, strikingly resembles the little spheroids of carbonate of lime that are deposited every day in the basin from which the thermal springs of Carlsbad gush and whirl. At times we may recognize clearly that solutions of peroxide of iron have acted upon the limestone which they bathed, for they have gradually corroded it. This chemical action has also been exercised on animal and vegetable matters. At many places in Alsace the mineral contains minute fibrous fragments consisting of woody rem-

nants, or the wood, without losing its texture, has been completely replaced by peroxide of iron and quartz.

Nothing is clearer than the intervention of subterranean waters in the origin of many masses of calamine, in which zinc occurs in the condition of a carbonate and a hydrated silicate, at Veielle-Montagne, for example, not far from Aix-la-Chapelle. The mining works have enabled us to recognize and follow the channels of the generating springs in all their details. The calcareous walls between which they made their way have been attacked, and, as we have just seen to have been done with peroxide of iron, zinc-mineral has been gradually substituted for carbonate of lime. The springs that held the mineral in solution issued from faults, and insinuated themselves into the permeable strata, flowing upon the surface of the impermeable beds. Vestiges of fossil shells, sometimes including the minerals of zinc and lead, in Westphalia, for example, likewise attest the substitution of metallic combinations for limestone. The lead and silver mines of Laurium, one of the principal sources of Athenian wealth, which figured in the budget of that state from the year 520 B. C., have revealed, perhaps still more evidently, in their vast excavations, the same processes of Nature.

Similar instances occur in many other countries. We cite in France the various calamine beds on the circumference of the central plateau; and, in the United States, in the Rocky Mountains, the important beds that have given rise to the towns of Eureka and Leadville. Notwithstanding local differences, all these masses of calamine present striking analogies, quite independent of the age of the beds in which they are spread. The metallic sheets are always in the same relation of situation with respect to the permeability and chemical nature of the rocks as they would be to-day, if the metalliferous waters were continuing to flow. It is thus made possible to determine exactly all the ruling conditions of these ancient zinc-bearing streams.

Phosphorus is most usually found in the crust of the earth in the state of phosphate of lime or phosphorite. It is extracted for the wants of agriculture from certain layers of the stratified beds and in the cretaceous formation, particularly in the beds called the gault, the same as those from which flows the water of the well of Grenelle. This mineral has been worked very actively since 1855 in several of the departments of France, in England, Bavaria, North Germany, Russia, Spain, and Poland. It also exists in remarkable quantities in the Jurassic. It often, in these beds, contains animal forms, as of bones, indicating that it has passed through life. But when it appears in eruptive rocks and metalliferous veins, its origin is wholly independent of the action of organized beings. Like the metals, the phosphorus now

contained in the sedimentary beds originated chiefly from the interior reservoirs of the globe, whence it has also been brought by the agency of thermal springs. This is illustrated in the important beds of Estremadura, where phosphorite associated with quartz constitutes numerous vertical veins, which have been filled up from below. Incidentally, the substance has penetrated the calcareous strata, and has assumed the forms of fossils within them, thus bringing a new proof of aqueous precipitation.

Still more frequently than any other substance, is quartz distributed in large veins. The granitic plateau of France, Brittany, the Vosges, and the Pyrenees presents numerous examples of it. These veins can often be perceived from a considerable distance. Besides crystallized quartz, they frequently contain parcels of metalliferous minerals, and thus represent transitions toward metalliferous veins proper. The ribboned texture of chalcedony and agate, which abound in these veins, and the manner in which they are related to deposits of precisely the same nature, inclosed in adjoining strata, confirm the view of their aqueous origin and permit their age to be determined. This is exemplified in the department of the Loire, where these veins are thus associated with porphyry, and at the northern point of Morvan; and in the remarkable quartz-veins of the Sierra Nevada, in California, which are auriferous at some points. Comprised within a zone some nine or ten miles wide, they extend from north to south along the chain for nearly two hundred miles. One of the most considerable of these, "the great quartz-vein," can be followed over more than thirty-five miles.

In fact, all these outflowings of quartz and connected minerals, whatever may be the diversity of their forms, in veins, masses, or strata, attest, not less authentically than the metalliferous beds, the intervention and generative power of subterranean waters which have been long since exhausted. We shall next see that waters sufficiently superheated deposit as quartz-crystal the silica which they hold in solution. It is thus explained how this mineral has in a certain way become the binder-up of the fractures of the terrestrial crust.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

A CONNECTION may be hypothetically traced between the frequent earthquakes in South America and certain subsidences which appear to be going on in the Andes. The city of Quito has sunk 26 feet in 122 years; the farm of Antisana—the highest inhabited spot on the globe—165 feet in 64 years; and the peak of Pichincha 218 feet in 122 years. The squeezing of the crust of the earth which is produced by such sinking of the masses of these ranges must produce violent dislocations in the surrounding regions; and these are the terrible earthquakes which we witness.

WRITING-MACHINES FOR THE BLIND.

By ARTHUR GOOD.

A NUMBER of philanthropists before Valentin Haüy had thought of various means of facilitating the education of the blind and placing them in relations with seeing persons; but, ingenious as their isolated attempts may have been, the necessary cohesion to constitute them a single whole was lacking in them, and they were destined to disappear with their authors. In the sixteenth century, Lucas, of Saragossa, conceived the idea of tracing the letters of the alphabet in hollows on wood. Moseau, of Paris, in 1640 devised the first characters in relief, but he was not encouraged, and gave up his experiments. The English blind scholar Sanderson constructed the first calculating tablets. Diderot tells of books which were printed by Prault for blind Mlle. de Salignac, who died in 1763, but gives no further details on the subject. We are likewise ignorant of the methods followed by Bernouilli, at the beginning of the seventeenth century, for the instruction of Mlle. Valdkirk. The obscurity which prevails concerning these essays made in times so near our own shows that they did not become general, either because the methods were not practical

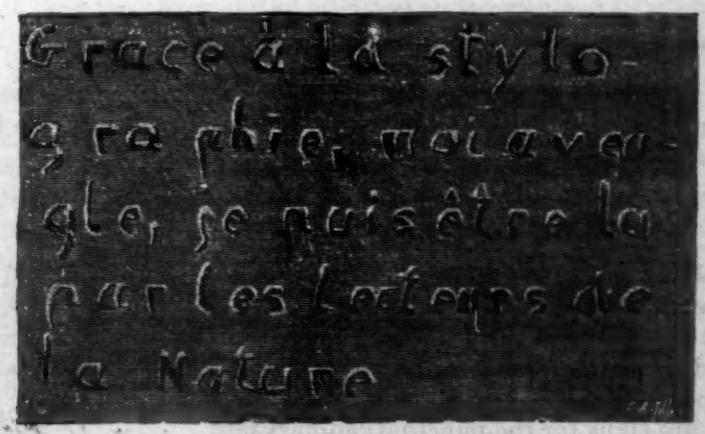


FIG. 1.—FAC-SIMILE OF A STYLOGRAPHIC INSCRIPTION IN RELIEF, WRITTEN BY A BLIND MAN FOR THE JOURNAL "LA NATURE."

enough, or because they were not pushed with sufficient energy. The methods of Haüy and Louis Braille were more successful.

Valentin Haüy, born in 1745, was a brother of the celebrated mineralogist, to whom we owe the "Crystallography." Struck with the success of the labors of his contemporary, the Abbé de l'Epée, for the deaf-mutes, he resolved to give to the blind also facilities for instruction and means to cultivate their minds. By

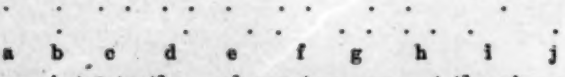
an inspiration of genius, he conceived what might be asked of the touch, which is so marvelously developed in the blind. Having made some characters in relief representing the letters of the alphabet, he undertook, in 1784, the education of a blind mendicant named Lesueur. The pupil's rapid progress soon made the inventor's name celebrated. This attempt was the origin of the Institution for the Blind in Paris.

Louis Braille, son of an artisan, like Haüy, completed the work of his predecessor. He was born at Compvray in 1809, and lost his sight, when three years old, in consequence of an injury he received from a knife. He entered the Paris Institution for the Blind in 1819, and became distinguished as a pupil, and afterward as a professor. He published, in 1829, his admirable "Anaglyptographie," or method of reading and writing by points in relief. He was inspired to this work by observing the cryptographic system devised in 1819 by Barbier, the artillery-officer, and constructed a method of admirable simplicity. It is equally well adapted to manuscript work and to printing: it can be applied to orthographic writing, to stenography, to mathematics, and to music. It has been used in printing books since 1849, and is still very generally in favor.

The basis of the alphabet is a group of six points arranged in vertical lines of three each, like the six of dominoes, which are numbered downward, beginning on the left hand, thus:

1 . . 4
2 . . 5
3 . . 6

A first series of ten figures, obtained by a methodical combination of the four upper points, 1, 2, 4, and 5, constitute the fundamental signs.



a b c d e f g h i j

Adding point 3 to these characters, we get the signs of the second series, embracing letters from *k* to *t*. The addition of the points 3 and 6 furnishes a third series; and a fourth series may be obtained by adding the point 6 to each of the first ten characters. The points 4 and 6 placed before a letter make it capital; and there are signs for the punctuation-marks.

The numerical sign, composed of the points 3, 4, 5, and 6, changes into figures or numbers the signs or groups of signs of the first series which it precedes. Thus, the letter *a*, preceded by this sign, becomes the figure 1 ; the letter *b* figure 2, etc. The number 1234, for instance, would be written by prefixing the numerical sign to the group of letters *a b c d*

1234

The ordinal numbers are formed by using the points 2, 3, 5, and 6. Fractions are expressed by writing the numerator as a cardinal, and the denominator as an ordinal number. But Braille's numerals are not well adapted to mathematical calculations, for they make the operations too long and difficult. An adaptation of them to music is more convenient, and is strikingly different from the blind-man's notation described by Guillié. It represents the measures by button-molds, the values of the notes by pieces of cork of various thicknesses, a round note by a ring, a black note by a piece of money, rests by thongs of leather, etc., the whole being strung on a long cord.

The characters, printed or written in relief, are read by the inner side of the end of the forefinger of either the right or the left hand, the hands being held open over the page.

The Braille or anaglyptographic writing was done on a paper which was fixed upon a tablet of wood or metal with an undulating surface presenting parallel, horizontal, and equidistant grooves, of a uniform depth, and about as large as a school-slate. The wooden frame of this tablet is bored on the sides with holes at equal distances apart, into which are fastened with pins the ends of a guide. The guide is furnished with two rows of rectangular openings of the size of the generator sign of the Braille alphabet, while the width of the grooves in the plaque is so calculated that the height of the openings in the guide shall correspond with that of the grooves. The blind writer, holding vertically in his hand a stylus with a rounded point, forms in each of the openings one of the signs he desires to write; in consequence of the slight depth of the grooves, the stylus gives to the paper, which should be of suitable thickness, enough relief to make the writing legible without piercing holes in it. After each word the operator should "jump" an opening so as to give the needed space between that and the next word. The two lines finished, he lifts the guide lightly, and slides it along the frame till the pins drop into the next holes, when he is ready to begin two new lines. It should be remarked that the characters are written in hollows, and have to be read in relief. The writer is therefore obliged to write on the reverse of the paper and form the characters from right to left, in order that they may be read from left to right, as is the usual way. Some blind persons have written the equivalent of one hundred Alexandrine lines an hour on the Braille machine. Various forms have been given to instruments on the Braille principle, some of which are represented in the engraving (Fig. 2). In one kind the upper edge of the paper is held in a board which is hinged to the upper end of the frame. In another kind the paper is fixed between two frames which are boxed into one another, so that when one side has been written upon (*recto*) it can be turned and written

upon the other side (*verso*) in the interlinear spaces. This system vastly increases the capacity of the sheet of paper. There are also pocket tablets, or replets, of which different models are represented in the engraving; they are for the most part strips of undulated zinc, to which are hinged guides bearing several rows of openings.

Signora della Casa, an Italian woman, constructed the apparatus represented in the first figure of our engraving (Fig. 2). A

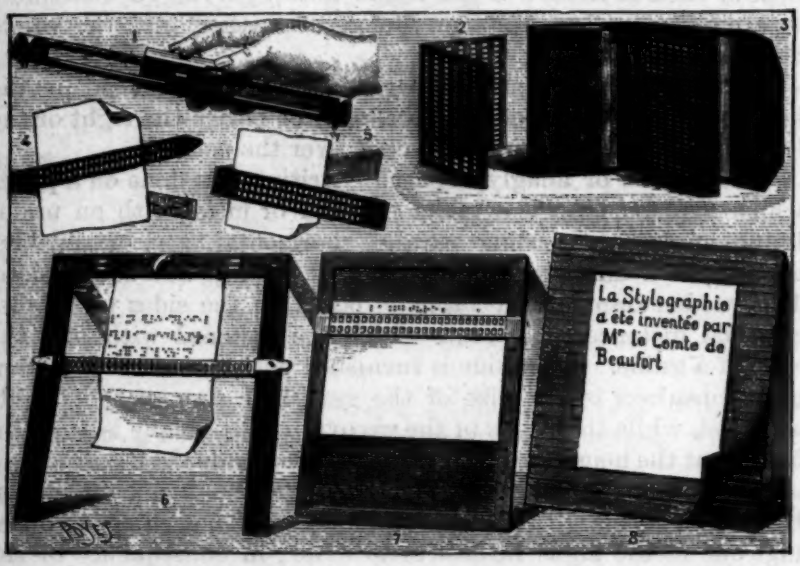


FIG. 2.—VARIOUS APPARATUS FOR WRITING BY THE BLIND. 1. Signora della Casa's piston-guide. 2. Recto-verso tablet of Laas d'Aguen. 3. Goldberg's Danish tablet. 4. English reglet. 5. Bailu's reglet. 6. Austrian tablet. 7. Braille's tablet. 8. Beaufort's stylograph.

little carriage bearing six buttons, which control as many movable pins, glides along a ruler that is notched at equidistant intervals. When one of the buttons is struck with the finger, the corresponding pin springs out and makes a point on the paper. A spring brings the pin back, and after the writing of each sign, the carriage is slid on a notch along the guide. But this apparatus is not in use, and we mention it only as a curiosity.

When we wish to write to a blind man by the Braille alphabet, we can accustom ourselves to reverse the signs by copying them as they look in a mirror; or we can use a table composed by M. Merricant, of Toulouse, which gives the characters written both ways; or we can learn only the reversed alphabet, and read the writing, if we have occasion to read it, on the hollowed or reverse side of the sheet, or the side on which it is written, which, with the eyes, will be easy enough.

For the use of blind in writing to seeing people, designs have

been invented in which the writer traces with a pencil the characters of the usual alphabet, assisting his pencil by guides pierced with openings. In the German system of Hebold, the letters are written in squares that are notched in each side. In the English Moon tablet, which is composed of narrow strips of wood glued

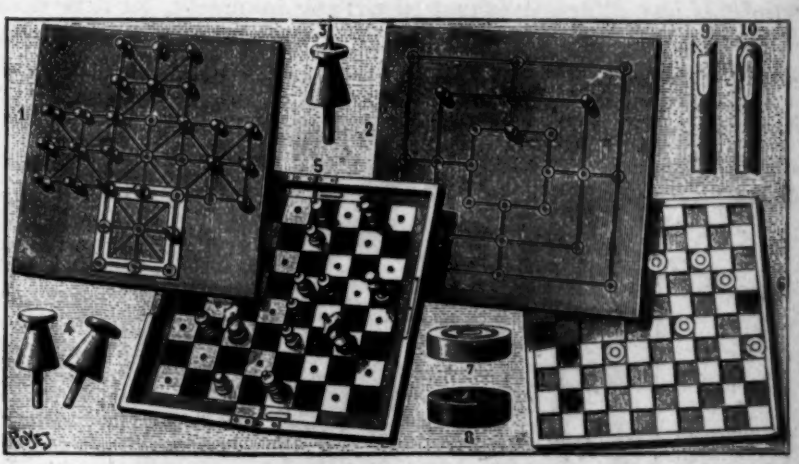


FIG. 3.—GAMES FOR THE USE OF THE BLIND. 1. Fortress. 2. Go bang. 3 and 4. Pawns. 5. Chess. 6. Checkers. 7 and 8. White and black checker-pieces. 9 and 10. Needles for the blind (much magnified).

upon cloth, the strips serve as rulers, or guides, along the edge of which the line is written, each one being rolled up when the line is finished, to give place to the next strip at the proper interval for the next line. Pencil-writing has likewise been studied by Guldberg in Denmark, Galimberti in Italy, and Bourgougnon in France. Valentin Haüy devised a method of pencil-writing by placing the paper upon a frame, in the interior of which were stretched parallel cords of catgut; between these cords may be traced signs of corresponding height. In Dūphan's instrument narrow strips of cardboard are pasted at equal distances upon a thicker sheet. The paper having been placed upon this widely furrowed tablet, the blind writer feels with the point of his pencil the edges of the strips that are in relief.

None of these systems, however, permit the blind man to revise what he has written. A writing in relief is what is wanted, which should be readable by seeing persons not initiated in the Braille system, and which the blind man too could trace and read with facility. Such a system is provided in the stylography which the Count de Beaufort has invented (Fig. 2, No. 8). The apparatus, or stylograph, is of the simplest character, and can be made at home by almost any one. Cover a sheet of paper with a piece of thick cotton-cloth; stretch this sheet over a series of parallel horizontal wires or cords about four millimetres apart; place upon this tablet

a sheet of paper, and with the stylus trace the letters of the usual alphabet, rounding the angles and neglecting the connections. The relief of the cords permits the letters to be made of equal height. After a short period of training, lines of letters can be written in *intaglio* for the blind man to read, by turning the paper over, in relief. If any difficulty is met in writing inversely, let it be done

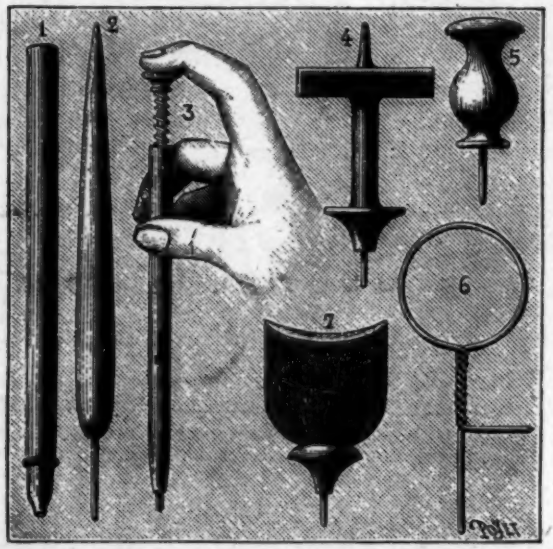


FIG. 4.—STYLUSES. 1. Austrian hollow stylus. 2. Stylus for the Goldberg tablet. 3. Ballu's stylus with an effacer. 4. Another model by Ballu, with a wooden effacer. 5 and 6. Common models. 7. Danish form.

in the regular order, and the blind reader, who has been accustomed to reverse his Braille characters, will have but little difficulty in making them out in their inverse shape.

Among other systems of writing for the blind, the most important is the English system, invented by Moon in 1847, and in which the first journal for the blind was printed. The signs are composed of points set very close together, or of lines in relief, reproducing simplified forms of ordinary letters. The Braille system has been introduced into England by Dr. Armitage, and is spreading in the English colonies. Germany, where the usual writing printed in relief was formerly used, definitely adopted the Braille system in 1879. It has been introduced into Russia and the Scandinavian countries. It is used exclusively in Italy, Belgium, and a part of Switzerland, and has been adopted in a few schools in the United States for music, while for the alphabet it has been modified or other systems are used.

The raphigraph is a machine devised by Braille and Foucault to facilitate communication between the blind and seeing people. It consists of a key-board with ten keys ending in needles and act-

ing with a perpendicular movement, which, for the formation of the written signs, is combined with a horizontal governed by the key-board, which moves a crank-screw. The paper is borne upon a carriage which changes place from line to line. Each graphic sign is numbered according to the needles that have to be struck to produce it. To form, for instance, the letter H with this machine, twenty marks have to be made, with as many strokes on the keys, and perhaps half as many displacements of the horizontal. The machine is too complicated to be practical.

Experiments were made by Hassenfratz in 1783, and Challaut in 1820, in using thick inks in writing which should produce a relief on the paper after they had dried; and the Abbé Vitali manufactured an ink which would give relief enough to be felt by the

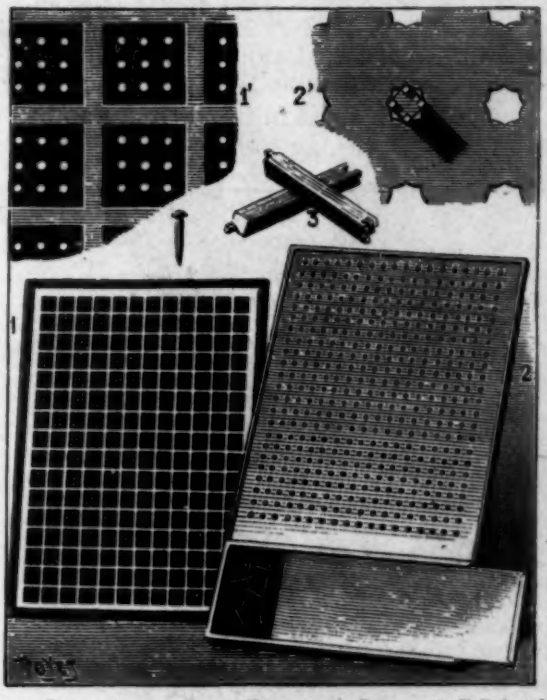


FIG. 5.—CALCULATING INSTRUMENTS FOR THE USE OF THE BLIND. 1. Ballu's tablet: 1' detail of the squares, a pin. 2. Oury's tablet: 2' detail of the octagons, red pins.

finger of the blind man. It has not been found convenient for writing, but has been applied with advantage to the drawing of geometrical figures, and for maps. Some of the most successful maps have been prepared by M. Trouillard, who uses linoleum, and indicates the rivers by iron wires, and mountains by more or less prominent undulations. The place of each city, the name of which is indicated by the initial letter in "Braille," is marked by a peg split at the top. A thread attached to the point that indi-

cates Paris, for example, can be fixed for the moment in these splits, as an aid in tracing the railway lines and measuring the distances between the several cities. Laas d'Aguen, in 1847, invented a kind of map which could be reproduced by printing. Previous to his, MM. Pignier and Boher Keller impressed maps in relief on thick paper, in which the meridians and parallels were represented by fine threads, boundaries by round points, mountains by large oval points, and seas and lakes by striæ. This method was adopted by the Moon Society in England and by the British and Foreign Blind Association, the first of which published atlases of terrestrial and celestial maps. M. Kunz, of Illzach, and M. Abel Pifre, of Paris, have published some most excellent maps, the former of which are very cheap, and the latter, the best of their kind, high.

M. Ballu took up some years ago the idea of Sanderson's tablet, for making arithmetical calculations. It is composed of a plaque divided by prominent metallic lines into many little squares pierced by nine holes arranged in threes, and numbered from 1 to 9 (Fig. 5, No. 1, 1′). Pins may be inserted into these holes, the

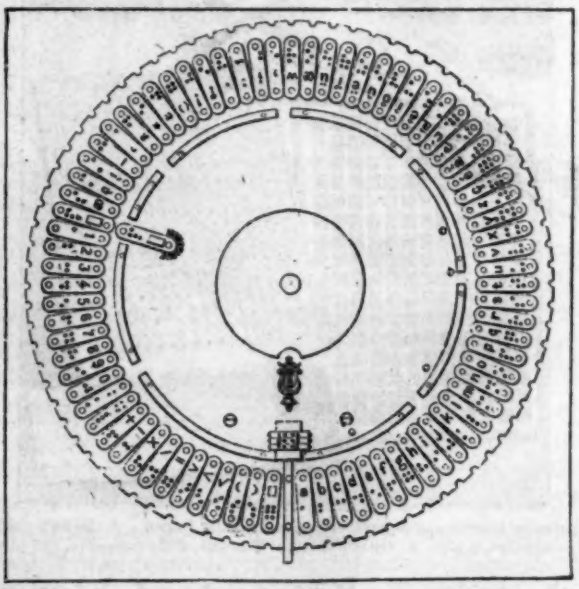


FIG. 6.—PLATE OF THE MAULER MACHINE.

rounded heads of which project above the surface of the plaque, and indicate the figures from 1 to 9, according to the number of the hole they occupy. The system is simple, but it takes a considerable time to learn it. In Taylor's tablet, the metallic plate is pierced with stellated octagonal holes, in which square pins with beveled ends are set, one of the ends being smooth and the

other toothed. As each pin can be disposed in the holes in sixteen different ways, it is easy to see that the system has considerable capacity. But the blind find it difficult to adjust the pins. A case has been made for working in vulgar fractions, in which metallic figures are set in square holes; but the apparatus can hardly be called a practical one. M. Oury has devised a modification of Taylor's tablets which has advantages over both of these instruments (Fig. 5, No. 2, 2′). M. Mauler's writing-machine consists essentially of a horizontal plate, having on its circular border a series of keys, each of which bears one of the

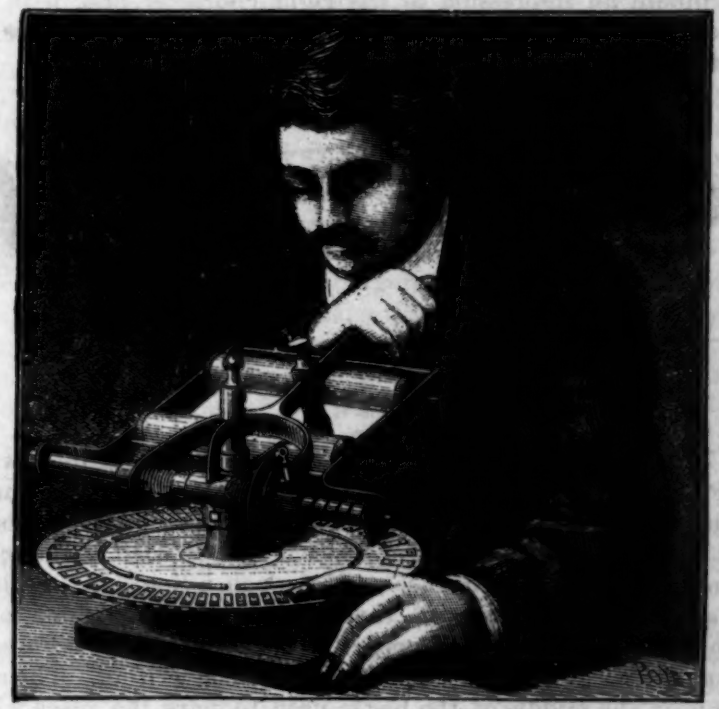


FIG. 7.—A BLIND MAN WRITING WITH THE MAULER MACHINE.

signs of the Braille alphabet and the corresponding letter of the ordinary alphabet, the two systems being arranged upon two concentric circlets. The plate, turning around a vertical axis, may be fixed at any position for the moment by means of a spring working into a notch. A frame, which turns upon a horizontal axis, supports two rollers upon which the paper is wound, and is moved by a lever which the writer holds in his left hand. Upon this lever slides a little tampon tipped with India-rubber, which may be fixed at will immediately over the line of either of the alphabets of the plate. When the writer has brought the letter he wants in front of him, and has fastened it for the moment in

place, he presses the lever down, bringing the paper in contact with the plate, forces the India-rubber-tipped tampon upon the character with such force as to obtain a relief impression of it on the paper. This done, he repeats the operation for his next character, and so on till his writing is done. This machine has the further advantage that the writer can revise his work by going over it with his fingers, and, if he finds that he has anywhere stamped the wrong character, he can bring the proper character under the tampon, insert the paper again at the spot where the wrong character appears, and, by a single application of the tampon, obtain an impression of the right character, and, with the same movement, obliterate the wrong one.—*Translated for the Popular Science Monthly from La Nature.*

FIG. 8.

[We add an engraving (Fig. 8) of the writing-machine devised by Prof. E. L. Youmans, the late editor of the "Monthly," during his blindness, which he used with much satisfaction till he recovered his eyesight. The sheet of paper is held in a slit in the roller, upon which it is rolled as it is written upon, a line at a time, leaving a blank for the next line, the proper spacing of which is determined by a ratchet. The pencil is kept in a straight course by means of the bar which is shown beneath the writing. The slide seen near the middle of the bar is used to mark the place where the writer leaves off—as at the end of a sentence.—EDITOR.]

PROF. JUDD claims for paleontology the right to be recognized as a distinct branch of science, because it deals with a class of objects and with objects in conditions with which biological methods alone can not cope. Its objects, besides being largely fragmentary, are in a mineralized condition, for which a peculiar knowledge and skill in petrology are required; it has, in the case of each deposit, to study the conditions under which the materials were laid down; and it has to determine the succession of processes to which the materials have been subjected through the ages since their original accumulation. Processes and knowledge are required in the solution of these problems which are afforded by no other single branch of science.

EXPERT TESTIMONY.

By Professor FRANK W. CLARKE.

OF all the causes which tend to discredit science, not one is more mischievous than the policy of the courts with regard to "expert testimony." Whenever a question of scientific fact or theory becomes involved in the settlement of a lawsuit, a swarm of "professional" witnesses are called, who testify on opposites sides, until neither judge nor jury can tell what is or is not really settled. Of these witnesses some are trained, some untrained; some are competent, some incompetent; some are scrupulous, others are unprincipled; and no sure rule of discrimination is properly applied between them. As a rule, all, though sworn, are expected to act like paid attorneys, each serving the side which employs him; and the one supreme test of capacity is that of shrewdness under cross-examination. Strange perversions of science thus get before the courts, to receive equal weight with worthy evidence; doubts are raised or exaggerated, and facts are misstated or suppressed. The highest scientific authorities, the men whose researches create science, are therefore averse to testifying, and rarely appear in the witness-box; for they can not risk their reputations upon one-sided or partisan statements, nor do they like the misrepresentations into which their evidence may be unscrupulously distorted, Under the present usage the expert bears witness for one side against the other; whereas the truth, being "neither black nor white, but gray," may stand in the middle of the disputed territory. The science of the court-room is litigious, not judicial; and no place is found for the unbiased presentation of fact, regardless of its bearing upon the personal interests at stake, and with fair credit given to genuine doubts and uncertainties. To the scientific partisan the court-room doors are wide open; to the scientific jurist they are practically closed, for no one wants his services. In criminal cases, perhaps, a better showing may be made; for here we have an impersonal state seeking to do exact justice, and its experts have no private ends to gratify. If, however, they are incompetent, the criminal, perhaps a poisoner, may escape punishment; and glaring cases of this kind are on record. Any experienced chemist can easily cite examples in point, for prosecuting attorneys are not always able to distinguish between true and false experts, and the latter sometimes destroy the evidence of crime in their blundering efforts to detect it.

Most men of science, and indeed most professional men, have two reputations—the one within, the other without the ranks of their colaborers. The two are rarely, if ever, quite commensur-

able, for popular repute may vary widely from true professional standing, and the quack is often better known to the world at large than the man of really solid attainments. There are quacks in science, just as elsewhere, and these men sometimes have prodigious popular reputations. One of them, widely known as an expert in the courts and on the certificates of patent-medicine venders, was once called upon to analyze a commercial product. "Do you want this sample analyzed to *buy* or to *sell?*" was his modest inquiry! Still another class of experts, having creditable standing among their fellows as regards knowledge and ability, is made up of men to whom a science is a trade rather than a profession; a business in which money is to be made, decently and honestly of course, but with no place in it for sentimentality or unselfish devotion to abstract principles. They enter the court-room, as do the lawyers, to win cases for their clients; not by unfair means or trickery, but by the strongest presentation of the *favorable* evidence. To present, as expert *witnesses*, the whole argument, *pro* and *con*, is not their recognized function. They answer certain questions, which have been carefully agreed upon beforehand; they evade opposing questions as far and as adroitly as possible; but science itself is not a client, and has no true representative in the court.

It goes almost without saying that, if science is to grow and flourish, it must be esteemed and respected by the community. Its advocates, therefore, to protect themselves, must oppose every policy which tends to its disparagement. Nearly every trial in which experts are called is harmful to the interests of science, for its supposed representatives too often forget their duty, and a feeling is spread abroad that all its conceptions are fanciful and uncertain. The disputes of litigation do not add to its dignity. It is, of course, impracticable to abolish expert testimony, even of the crudest and most venal kind; for each side in a suit has the manifest right to submit whatever evidence it can get in its own favor. The problem is, to modify the evil, and to reduce its influence to a minimum. How can this best be accomplished?

From what has already been said it will be easily seen that the position of an expert is different from that of an ordinary witness. The latter testifies to facts which, bearing directly upon the case under trial, are part of his personal knowledge, independently of all abstractions or principles. He has seen a murder committed, he identifies a person or a signature, he met a certain man at a certain time or place, and the like. On most of these points the testimony of the most ignorant laborer is as good as that of the highest scholar, for they relate to the narrowest and simplest kinds of experience, and involve no mental training whatever. The expert, on the other hand, is nearer akin to the

attorney; he testifies to matters which involve more than bare facts, which require special training, and reach out into points of delicate judgment, careful interpretations of evidence, and statements of what is or is not received as scientific opinion. The ordinary witness is well within the range of experience of every man on the jury; the expert speaks of regions into which the jurors have never entered. He testifies, but he also cross-examines, albeit by proxy; for he supplies the lawyers on the same side with himself with questions for the confounding of his adversary. The attorney is merely a legal expert who argues a case for his client, but is not sworn to speak the truth; the expert witness argues, but under an oath which admits of reservations. The two are different in matters of form, but not in matters of practice. They are, in short, colleagues.

Now in the organization of the courts the legal elements have a position of peculiar advantage. First, there are the opposing lawyers, who were once examined for admission to the bar, and who may be disbarred for unworthy or unprofessional conduct. Each argues his case in favor of his client, raising a legal fog or clearing away confusion according to which policy is the better. But over them is the bench, with its trained experts sitting in judgment on the case, deciding all principles of law as controversy arises, listening to and weighing the arguments, and finally, in jury trials, addressing a charge to the jury. The legal questions are discussed by legal experts, and decided by impartial legal arbiters; but the scientific problems which come before a court are subjected to no such arbitration. Just here a line of reform is plainly indicated—not as to the final settlement of scientific questions, of course, but at least as to their proper presentation before judges and juries. Between opposing experts only experts can decide.

Two measures at once suggest themselves: First, that all experts who desire court-practice should be registered, or go through some form of admission to practice, in such a way as to certify in a measure to their having received a proper scientific training. The time of the courts should not be wasted by scientific dabblers or amateurs. Experts should also be liable to something like disbarment for sufficient cause. Secondly, whenever the parties to a suit bring in expert testimony, the court itself should have the right to summon other experts, who, standing in a semi-judicial and non-partisan position, could listen to evidence and arguments, weigh both, and aid the judges either in the preparation of their opinion, or in framing their charge to the jury. So, just as the legal experts pass upon matters of law, the scientific experts would pass upon matters of science, and the results could not be other than favorable. Pretenders, getting less easily before the courts,

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would testify less confidently if they knew that all their statements were to be properly reviewed; science itself would be more fairly represented, public interests would be subserved, and charlatanry would be the only sufferer.

ANIMAL AND PLANT LORE.

By Mrs. FANNY D. BERGEN.

II.

BEFORE narrating any further natural history superstitions, I wish cordially to thank, one and all, the many readers who have so kindly written, now to express an interested recognition of some belief of their own childhood, and again to send other superstitions from different localities. Such of these fancies as had not already been collected for the present article I gladly insert. The beliefs here mentioned consist more largely than did those described in a previous paper * of such as are shared alike by children and adults.

One correspondent expressed strong doubt as to whether children manifested much originality in their mythical conclusions, thinking that the latter were almost always exaggerated or grotesque distortions of ideas which they had gathered from their elders, often from their nurses. Recognizing the full power of these influences, I must still give the children credit for originating many of the strange notions under consideration. I can not better illustrate this ability of children to form original conclusions, however incorrect, than by quoting from another correspondent, a physician, who says:

"I think I could not have been more than four years old when I began to question myself as to where I came from, and why I was not a boy—for my father, like Mr. Dombey, wanted a *son* for the 'house'—and from my earliest remembrance I have had it impressed upon me that girls were worse than useless things, and that to be something that would grow up into a man was 'a consummation devoutly to be wished.' I wondered what was the difference (and it was a very great difference) between my father and my mother. 'Surely,' I thought, 'there is no greater differerence between my dog and cat, between the horse and cow,' and I reasoned, therefore, that the dog must be the male of the cat, the horse of the cow, the turkey of the hen, and so on. I shall never forget with what complacency I decided in my own mind this great question, nor how reluctant I was to discard it, even when a

* See "The Popular Science Monthly" for July, 1886.

big girl." This is a most unique bit of child's reasoning, but doubtless each of us can recall personal experiences, if less curious, no less to the purpose. Science is constantly extirpating errors and uprooting old conceits, but meanwhile new ones or modified forms of older ones arise; thus, it has come about that some of our New World zoölogical and botanical fables are of recent birth, although very many, especially those that constitute connected myths, are undoubtedly not indigenous, but, as the floras have it, "naturalized from Europe" or "Asia." It would be a labyrinthine task to attempt to trace out, even approximately, the birth and development of some of the latter that still hold extended sway, but many of them certainly are of very remote origin.

There seems to be the best of reason for believing that, to seek the origin of the popular delusion concerning the curative properties of certain animal excreta, we must study the mythology of our long-ago Aryan ancestors. It would not be in keeping with the object of the present paper to occupy the space necessary to give more than a mere suggestion of the character of the great pastoral poem that is embodied in the old Aryan myth which is described in such interesting detail by De Gubernatis in his "Zoölogical Mythology." Probably every mythical or legendary account of the phenomena of Nature is more or less a mirrored reflection of the environment of its authors: so (as we might have expected) we find that the character of the mythology developed on that ancient Asiatic table-land, to which philologists and ethnologists now look back as to the source of the many branches of the great Indo-European family, was a natural outgrowth of the simple life led by the primitive herdsmen and farmers among whom it arose. Dwelling amid abundant herds, which furnished at once their occupation and their principal sustenance, in an atmosphere redolent of the breath of cattle, this pastoral race most naturally transferred the names and attributes of these objects of their daily care to the heavenly bodies and to various meteorological occurrences. The sky, for them, was peopled with cows and bulls, and celestial phenomena were personified in language which was already in daily use, in its literal sense. Thus arose a whole system of zoölogical mythology, in which the animals represented and all pertaining to them bore symbolic meanings. A literal interpretation of certain of these mythical beliefs gave rise to "the superstitious Hindoo custom of purifying one's self by means of the excrement of a cow." Later, the same custom passed into ancient Iran, where the urine of various animals was made use of in religious rites. How much stress the sacred books of the Parsees laid upon this mode of lustration may be gathered from the brief account of the use of the "Nirang," as the liquid in question is called, given in Max Müller's "Chips from a German Workshop."

It has often happened that substances as well as ceremonies, which originally had a religious signification, in later ages degenerated into fancied cures for disease; so, is it not more than probable that the employment of animal excreta as remedies among the less intelligent classes in different parts of Europe, in both earlier and later times, as well as in our own newest offshoot from the Indo-European stem, is a survival of early Aryan religious observances?

Many ignorant people in various parts of the United States to-day believe that a decoction made by steeping in water the manure of sheep is a sovereign remedy in measles, and very similar notions are found among the English and German peasantry. In one of Bale's "Interludes," published in 1562, in which various remedies for common ailments of the lower animals are recounted in quaint verse, the same substance is recommended as "wholesom for the pyppe." In that repertory of curious information, Brand's "Popular Antiquities," the following statement is quoted from a statistical account of County Stirling, in Scotland: "A certain quantity of cow-dung is forced into the mouth of a calf immediately after it is calved, or, at least, before it receives any meat; owing to this the vulgar believe that witches and fairies can have no power ever after to injure the calf." In Cumberland, England, a reputed cure for ear-ache is the application of a bit of wool from a black sheep moistened in cow's urine. Possibly it is a modified form of this latter notion that is found in the island of Mount Desert, where it is said that the wool must be wet in new milk; while in Vermont, to be efficacious, it is thought that the wool must be gathered from the *left* side of the neck of a perfectly black sheep. In other localities negro's wool is a reputed cure for the same pain. It seems almost incredible, whatever their origin, that remedies of so offensive a character as many of those above given can still retain a place even in the rudest traditional pharmacopœia, but there seems to be in the uneducated human mind a sort of reverence for or faith in that which is in itself disagreeable or repulsive. This idea apparently rules instead of rational judgment in the selection of many popular household remedies in the shape of oils of most loathsome derivation, such as "skunk-oil," "angle-worm oil" (made by slowly rendering earth-worms in the sun), "snake-oil" of various kinds, etc. George Borrow, in that rare idyl of vagabondage, "Lavengro," tells of various encounters with an old herbalist who always carried on his back a stout leathern bag, into which he gathered not simples but vipers, whose oil he extracted for medicinal purposes. The faith of this wandering English mediciner and his numerous customers of half a century ago in the viper-oil is quite equaled to-day by that of American frontiersmen in the peculiar virtues of rattlesnake-oil. It is just possible that subtle remedial powers

do exist in some of these oils, but it is not easy to ascertain why lard or olive-oil might not take the place of these disgusting unguents.

The belief in "snake-oil" as a remedy is probably only one phase of the feeling which so often and among such different races has given rise to serpent-worship. Since the publication of a previous paper, in which several popular superstitions about snakes were mentioned, a few additional ones have come to my knowledge. In various parts of New England it is commonly believed, even by people of a good deal of intelligence, that rheumatism and sprains may be relieved by wearing a dried snake-skin—according to some, that of a black snake—about the part affected. The dried skin of an eel is often used instead, very likely from the common misapprehension which classes this fish among snakes. Dried skins of snakes are often kept ready for use in New England barns, as it is currently believed that a portion chopped up and mixed with the food of a cow after parturition will obviate any difficulty there may be in securing the expulsion of the placenta. The cow-boys of the West often wear the rattles of the rattlesnake in their hat-linings as a cure for or preventive of headache—the greater the number of rattles the more certain the remedy. In some parts of England a snake's tooth is frequently carried as a charm against drowning. The belief that sound teeth may be secured by biting into a live black snake I find exists in many places in the United States, both North and South. An interesting Tennessee notion is that the first thunder in the spring "wakens the snakes," and from that time forth one must beware of meeting them. There also ferns are popularly called "snake-weeds," as it is supposed that snakes abound in their vicinity, and so both children and adults are afraid to walk where ferns grow, for fear of being bitten by the reptiles. In the same State it is not uncommon after killing a snake, in time of drought, to hang it on a tree for three days as a sure means of bringing rain. In other localities in the South it is said that the snake must be hung with "its back down," if rain be desired, for if the back be turned skyward it will certainly prevent rain. The belief, so very general in the United States, that any and every species of snake is poisonous, and the bite or "sting" therefore dangerous, is also prevalent in Nova Scotia, and it is there thought that the wound of a snake is certain to be deadly unless the victim can manage to reach water before the snake can, in which case the latter will die, and the person bitten will recover. A common warning throughout New England is, "You mustn't let a snake spit in your mouth, or it will certainly kill you!" The idea that a snake's saliva must be poisonous is quite in keeping with the host of other misconceptions concerning the

powers and qualities of the animal, but the utter impossibility of such feats of expectoration would seem self-evident to the most untrained observer. One not familiar with the unreasonable horror which usually impels people to flee from even the most harmless snake might infer from the form of this injunction that the much-slandered reptiles are frequently kept as pets, and are therefore on such terms of familiarity with human beings as to make it easily possible for this fabled spitting into the mouth to occur. In Peabody, Mass., I have heard of a notion that I have not met with elsewhere—viz., that a snake will not go near where geraniums grow.

A physician formerly from De Kalb County, Ill., reports that illiterate people there believe that a whiff, however slight, of the breath of the "blow-snake" (*Heterodon platyrrhinus*) is "sure death." A stalwart young man, while out hunting, has been known to faint simply because he fancied that a "blow-snake," which his companion was teasing, had reached him with its fatal breath. The blow-snake of Illinois is variously known in other localities as hog-nose, flat-head, viper, and puff-adder. This quite harmless snake affords what I think we may unquestionably call a fine example of protective resemblance, for so cunningly does he mimic the appearance and behavior of some really venomous snakes that his threatening aspect in general strikes terror into the beholder. In Maine, if a cow that has been grazing gives less milk than usual, or than is expected, it is often believed that the common garter-snake has sucked the cow. This strange belief, doubtless, is of remote origin, as it is very common among the housewives of the Russian peasantry.

How great a place not serpents alone, but other reptiles, and batrachians as well, have occupied in the popular imagination as possessors of magical powers, is well shown by the composition of the witches' hell-broth in "Macbeth":

"Round about the caldron go,
In the poisoned entrails throw.
Toad that under cold stone
Days and nights hast thirty-one
Sweltered venom sleeping got,
Boil thou first i' the charmèd pot!

. . . . .

Fillet of a fenny snake,
In the caldron boil and bake;
Eye of newt and toe of frog,
Wool of bat and tongue of dog,
Adder's fork and blind-worm's sting,
Lizard's leg and owlet's wing,
For a charm of powerful trouble
Like a hell-broth boil and bubble."

In the Southern States the bite of a harmless little green lizard (*Sceloporus ?*) is considered fatal. The negroes and poor whites call the little fellows "skyarpins" (scorpions ?). Despite the reputed poisonous nature of these lizards, children are fond of teasing them, holding them at bay with a long stick, and provoking them to "show their money-bags," for, when angered, they have the power to distend and somewhat change the color of their throats. A queer superstition concerning another lizard (the *Zoötoca vivipara*) is found in the north of England. It is there said that if one pick up one of these creatures and touch its back with the tongue, that organ will thenceforth be endowed with a magical power to cure burns. The belief that a turtle can come out of its shell whenever it likes is not uncommon in the Southern States. In Bucks County, Pa., it is believed that if some one's initials be carved on the under shell of a turtle, it will never leave the locality—an excellent example of the *post hoc ergo propter hoc* style of reasoning.

The saying that if a turtle bites you it will not let go till it thunders, is sent me from both Tennessee and Maine. Being found in localities so far apart, I dare say it may be more widespread. In New Brunswick the story goes that the turtle will not let go until sundown. It is a fashion among children, and to some extent among grown-up people as well, along the New England coast, to carry in the pocket a small bone which is called a "lucky-bone." Sometimes this is a small bone cut from a turtle while the animal is yet alive. Again the small, serrated, enameled, and very white bone found in the head of a codfish serves the purpose of bringing good luck. Farther west, in the habitat of the gar, a small bone from the head of this fish is supposed to possess the charm; while in Petit Codiac, N. B., the globular head of the femur of a pig is often kept as a lucky-bone in a box or bureau-drawer. Somewhat akin to those just mentioned is a superstition found among the Russian peasantry, which runs as follows: If a bat which has become entangled in one's hair at midnight be killed, and a small bone in or about the shoulder (I can not ascertain just what one it is) be taken out and carried in the pocket, it will have the power to render the bearer invisible at will.

In one village at least in eastern Massachusetts the passer-by may often hear children call out to their playfellows, if a toad appear on the playground, "Don't step on that toad, or your grandmother'll die!" Less general than the belief that handling a toad will produce warts is the fancy that it will cause freckles. An English superstition is that to carry the head of a frog wrapped in silk will protect one from the gallows. In the neighborhood of Halifax, N. S., the yellow-spotted salamander (*Amblystoma punc-*

tatum) is known as "man-creeper" or "man-killer," and it is thought that each contains poison enough to kill (if given internally) as many men as the animal has spots!

There are a great many stories afloat of snakes having lived for months or even years in the human stomach. I quote the following account from the "Bucks County Intelligencer," Pa.:

"A Connecticut lady tells us that, as a child, she knew of more than one person 'who had swallowed a snake's egg.' The snake grew, and when hungry, would 'cluck' in the throat of its unwilling host. The only way to get rid of the uncanny tenant was for the person to fast until hunger compelled the snake to venture out to a plate of untasted victuals upon the table. This is a genuine myth that no doubt still exists in the central part of Connecticut."

A Massachusetts country girl told me of another case which she said she had never thought of doubting; a lady was long annoyed by the presence of a snake in her stomach supposed to have been swallowed while still very small in drinking-water. She finally decoyed from its quarters the unwelcome occupant by boiling a large dish of milk, over which she bent until the snake came out to feed. Similar myths are common in New England, New Brunswick, and Nova Scotia, in which eels or "lizards" (newts) take the place of snakes. In the "South End" of Boston there lives a man who is nicknamed "Lizard" by the street-boys, because it is currently reported that he for many years unwillingly entertained one of these batrachian parasites. In every instance it is believed that the only relief possible is to coax forth the creature by some tempting dish of food or drink. I can not refrain from quoting verbatim another of these fables which I heard narrated not long since:

"I knew uv a man in Nova Scotia, who wuz drinkin' frum a pond one day, 'nd he swallowed a young lizard that lived 'nd grew in his stomach a long time. At last he suffered so much that his frien's bound um fast t' a tree so he couldn' help umself to water er any kind uv drink, 'nd kep' um fer three days on salt pork. Uv course 't the end uv that time he wuz very thirsty, 'nd ez soon ez his ropes were untied he hurried to a runnin' brook 'nd bent down over the water t' drink, 'nd the lizard came out t' drink, 'nd so he got rid of um."

In the Boston papers more than a year ago this oft-repeated story appeared in a still more incredible form. A bat was reported to have been expelled alive from the stomach of a woman, where it had lived for seven years on a diet consisting chiefly of milk and water. Probably most such fictions could be disposed of in as summary a way as that in which the well-known comparative anatomist, Prof. Jeffries Wyman, is said, in a printed

anecdote, to have dealt with one of these alleged denizens of the human stomach:

"Prof. Wyman, on entering the office of his friend Dr. Augustus A. Gould, an eminent Boston physician, was asked his opinion about a curious case. His friend, a clergyman, had just brought in an animal which he said a worthy parishioner of his, a man of unimpeachable veracity, after some years of suffering in his stomach, had recently vomited, while sitting on a rock in an open field. The animal tried to escape, but was caught. Prof. Wyman at once recognized it as a young blacksnake, which could not have lived years in the man's stomach and then been vomited. The clergyman indignantly denied that his worthy parishioner could be mistaken or would deceive, and wanted to argue the case. The professor said he would not waste time in dispute, and with his penknife immediately opened the reptile's stomach and turned out some grasshoppers, beetles, and other remnants of the usual food of such animals. He said to the clergyman, 'It seems that your parishioner has a liking for a peculiar kind of diet.'"*

HOW THE OPIUM-HABIT IS ACQUIRED.

By VIRGIL G. EATON.

I AM not one of the persons who raise a great cry about the evils of the "opium-habit." I have no doubt that the continued use of narcotics, whether they be tobacco or opium, is injurious to the nervous system; but I also firmly believe that the recuperative powers of the body are such that they can largely overcome any harmful results coming from the regular use of these substances. For instance, I know a stone-cutter who resides at Cape Elizabeth, Me., who for the past twenty years has used twenty cents' worth of black "navy plug" tobacco every day. He is a large, vigorous man, weighing over two hundred pounds. His appetite is good; he sleeps well, and, save for a little heart disturbance caused by overstimulation, he is perfectly healthy, and is likely to live until he is fourscore. He is now fifty-one years of age, and he assures me he has used tobacco since he was fourteen, and never had a fit of "swearing off" in his life. A peculiar and, I should say, a rather troublesome habit of his, is to go to bed every night with a big "quid" of hard "plug" tobacco between

* The writer will gratefully acknowledge the receipt of additional myths of similar character to those here given, with a view to subsequent fuller treatment of the subject. It will be of service if considerable detail be given in regard to the geographical or social boundaries of the superstition, and if the latter be stated as explicitly as possible. (Address Mrs. Fanny D. Bergen, 17 Arlington St., North Cambridge, Mass.)

his molars. As this is always gone in the morning, and the pillow shows no traces of the weed, he thinks he chews it and swallows it in his sleep, though he never knows anything about the process.

There is a widow who keeps a lodging-house in Oak Street, Boston, Mass., who takes three drachms of morphia sulphate every day, in three one-drachm doses, morning, noon, and night. When it is remembered that an eighth of a grain is the usual dose for an adult, while two grains are sufficient to kill a man, the amount she takes seems startling. I asked her why she did not try and substitute tobacco, or bromide, or chloral hydrate for morphine, and she said they made her sick, so she could not use them. This woman is sixty years old, very pale and emaciated. Her appetite is poor. She attends to her duties faithfully, however, and is able, with the help of a girl, to carry on a large lodging-house.

I might give scores of instances similar to the above, but these will do for my purpose. I believe that the person who takes liquor or tobacco or opium, in regular quantities at stated intervals, is able to withstand their effect after getting fixed in the habit, and that it is the irregular, spasmodic use of these articles which brings delirium and death. It is the man who goes on a "spree," and then quits for a time, who has the weak stomach and aching head. His neighbor, who takes his regular toddy and has his usual smoke, feels no inconvenience.

For the past year or more I have studied the growth of the opium-habit in Boston. It is increasing rapidly. Not only are there more Chinese "joints" and respectable resorts kept by Americans than there were a year ago, but the number of individuals who "hit the pipe" at home and in their offices is growing very fast. A whole opium "lay-out," including pipe, fork, lamp, and spoon, can now be had for less than five dollars. This affords a chance for those who have acquired the habit to follow their desires in private, without having to reveal their secret to any one. How largely this is practiced I do not know, but, judging from the tell-tale pallor of the faces I see, I feel sure the habit is claiming more slaves every day.

In order to approximate to the amount of opium in its various forms which is used in Boston, I have made a thorough scrutiny of the physicians' recipes left at the drug-stores to be filled. As is well known, all recipes given by physicians are numbered, dated, and kept on file at the drug-stores, so that they may be referred to at any time. To these I went in search of information.

I was surprised to learn how extensively opium and its alkaloids—particularly sulphate of morphia—are used by physicians. I found them prescribed for every ailment which flesh is heir to. They are used for headache, sore eyes, toothache, sore throat,

laryngitis, diphtheria, bronchitis, congestion, pneumonia, consumption, gastritis, liver-complaint, stone in the gall-duct, carditis, aneurism, hypertrophy, peritonitis, calculus, kidney trouble, rheumatism, neuralgia, and all general or special maladies of the body. It is the great panacea and cure-all.

During my leisure time I have looked up more than 10,000 recipes. It has been my practice to go to the files, open the book, or take up a spindle at random, and take 300 recipes just as they come. The first store I visited I found 42 recipes which contained morphine out of the 300 examined. Close by, a smaller store, patronized by poorer people, had 36. Up in the aristocratic quarters, where the customers call in carriages, I found 49 morphine recipes in looking over 300. At the North End, among the poor Italian laborers, the lowest proportion of 32 in 300 was discovered. Without detailing all the places visited, I will summarize by saying that, in 10,200 recipes taken in 34 drug-stores, I found 1,481 recipes which prescribed some preparation of opium, or an average of fourteen and one half per cent of the whole.

This was surprising enough; but my investigations did not end here. Of the prescriptions furnished by physicians I found that forty-two per cent were filled the second time, and of those refilled twenty-three per cent contained opium in some form. Again, twenty-eight per cent of all prescriptions are filled a third time; and of these, sixty-one per cent were for opiates; while of the twenty per cent taken for the fourth filling, seventy-eight per cent were for the narcotic drug, proving, beyond a doubt, that it was the opiate qualities of the medicine that afforded relief and caused the renewal.

From conversation with the druggists, I learned that the proprietary or "patent" medicines which have the largest sales were those containing opiates. One apothecary told me of an old lady who formerly came to him as often as four times a week and purchased a fifty-cent bottle of "cough-balsam." She informed him that it "quieted her nerves" and afforded rest when everything else had failed. After she had made her regular visits for over a year, he told her one day that he had sold out of the medicine required, and suggested a substitute, which was a preparation containing about the same amount of morphine. On trial, the woman found the new mixture answered every purpose of the old. The druggist then told her she had acquired the morphine-habit, and from that time on she was a constant morphine-user.

It was hard to learn just what proportion of those who began by taking medicines containing opiates became addicted to the habit. I should say, from what I learned, that the number was fully twenty-five per cent—perhaps more. The proportion of those who, having taken up the habit in earnest, left it off later on, was

very small—not over ten per cent. When a person once becomes an opium-slave, the habit usually holds through life.

I was told many stories about the injurious effects of morphine and opium upon the morals of those who use it. One peculiarity of a majority is that, whenever a confirmed user of the narcotic obtains credit at the drug-store, he at once stops trading at that place and goes elsewhere. All the druggists know this habit very well, and take pains to guard against it. Whenever a customer asks for credit for a bottle of morphine, the druggist informs him that the store never trusts any one; but if he has no money with him the druggist will gladly give him enough to last a day or two. In this way the druggist keeps his customer, whereas he would have lost his trade if the present had not been made at the time credit was refused.

Of course, I heard much about the irresistible desire which confirmed slaves to the habit have for their delight. There is nothing too degrading for them to do in order to obtain the narcotic. Many druggists firmly believe that a majority of the seemingly motiveless crimes which are perpetrated by reputable people are due to this habit. In pursuit of opium the slaves will resort to every trick and art which human ingenuity can invent. There is a prisoner now confined in the Concord (Mass.) Reformatory who has his opium smuggled in to him in the shape of English walnuts donated by a friend. The friend buys the opium and, opening the walnut-shells, extracts the meat, and fills up the spaces with the gum. Then he sticks the shells together with glue and sends them to the prison.

At present our clergymen, physicians, and reformers are asking for more stringent laws against the sale of these narcotics. The law compelling every person who purchases opium or other poisons to "register," giving his name and place of residence to the druggist, has been in force in Massachusetts for several years, and all this time the sales have increased. No registration law can control the traffic.

The parties who are responsible for the increase of the habit are the physicians who give the prescriptions. In these days of great mental strain, when men take their business home with them and think of it from waking to sleeping, the nerves are the first to feel the effects of overwork. Opium effects immediate relief, and the doctors, knowing this, and wishing to stand well with their patients, prescribe it more and more. Their design is to effect a cure. The result is to convert their patients into opium-slaves. The doctors are to blame for so large a consumption of opium, and they are the men who need reforming.

Two means of preventing the spread of the habit suggest themselves to every thoughtful person:

1. Pass a law that no prescriptions containing opium or its preparations can be filled more than once at the druggist's without having the physician renew it. The extra cost of calling on a doctor when the medicine ran out would deter many poor people from acquiring the habit. Such a law would also make the doctors more guarded in prescribing opiates for trivial ailments. With the law in force, and the druggists guarded by strict registration laws, we could soon trace the responsibility to its proper source, and then, if these safeguards were not enough, physicians could be fined for administering opiates save in exceptional cases.

2. The great preventive to the habit is to keep the body in such a state that it will not require sedatives or stimulants. The young men and women in our cities have too big heads, too small necks, and too flabby muscles. They should forsake medicine, and patronize the gymnasium. Let them develop their muscles and rest their nerves, and the family doctor, who means well, but who can not resist the tendency of the age, can take a protracted vacation. Unless something of the kind is done soon, the residents of our American cities will be all opium-slaves.

STIGMATIZATION.

By Rev. RICHARD WHEATLEY.

THE stigmata—what are they? Wounds resembling those received by the Lord Jesus Christ at his crucifixion. When fully developed they consist of one in the palm of each hand, one on the dorsum of each foot, each indicating the place where a nail was driven in the act of nailing Christ to the cross, and one on the side, showing the effect of the Roman soldier's spear-thrust. Sometimes, in addition to these, there are signs upon the forehead, corresponding to the lacerations caused by the thorns. Stigmatization is the technical ecclesiastical term for the formation of such resemblances.

Görres acknowledges that in all Christian antiquity no known examples of stigmatization occurred. They are peculiar to the later eras of Christian history. Roman Catholicism has usually enumerated about eighty instances, but in 1873 Dr. Imbert Gourbeyre, professor in the School of Medicine of Clermont-Ferrand, in Belgium, and a writer attached to that religious system, enlarged the series so that it now comprehends one hundred and fifty-three cases, of which eight are living and known to him. Of all these instances that of Francis Bernadone, canonized as St. Francis d' Assisi, in Italy, is the first and most commanding. Born in 1186 and dying October 4, 1226, he is said to have received the stig-

mata in 1224. In the solitude of Monte Alverno, a part of the Apennines bestowed on him by Count Orlando, of Cortona, and a favorite place of retirement, he thrice opened the Scriptures where they detail the passion of the Lord. This was interpreted to mean that in some way he was to be brought into mysterious conformity with the death of the Redeemer. While praying, he experienced a most passionate desire to be crucified with Christ, and saw, or imagined he saw, a seraph with six wings; two were arched over the head, two veiled the body, and two were stretched for flight. Amid these wings appeared the likeness of the Crucified. Joy filled the soul of Francis, but grief also pierced his heart like a sword. The vision vanished, but left him in an indescribable condition of delight and awe. His body, like wax exhibiting the impression of the seal, now showed the stigmata. Each hand and foot was pierced in the middle by a nail. The heads of the nails, round and black like nails of iron, were on the palms of the hands and fore part of the feet. The points of the nails, which appeared on the other side, were bent backward on the wounds they had made. Though somewhat movable, they could not be drawn out. St. Clare tried, but failed, to do it after his death. From a deep-red wound of three fingers' breadth in his left side, as if he had been pierced by a lance, the sacred blood then and frequently afterward flowed upon his tunic. These wounds never gangrened nor suppurated, nor did he try to heal them. Hands and feet could be used as aforetime, but walking became so difficult that on subsequent journeys he usually rode on horseback. Countless miracles were ascribed to these wounds. Fifty Franciscan brethren declared that they had seen them at one and the same time. Pope Alexander IV publicly affirmed that he too had seen them with his own eyes.

Christine de Stumbele, born near Cologne in 1242, and a hysterical, epileptic, and erotic woman, not only bore the five wounds on Good-Friday, but also the crown of thorns on Tuesday of Passion Week, and the bloody sweat on Holy Thursday. The details of her experiences, as given by Dr. William A. Hammond in his work on "Nervous Derangement," are what the English would call decidedly "nasty." Besides, she avowed possession and torment by a devil, which is not at all unlikely, in view of her filthy and degraded habits. Yet she is now honored as a saint by the majority of the Roman Catholic Church in that section of Europe.

Veronica Giuliani, a capuchin nun who died at Città di Castello in 1727, in an ecstasy prayed that she might be crucified with her Saviour, and saw five brilliant flaming rays issue from his wounds. Four represented the nails, and the fifth the lance. Heart, hands, and feet were simultaneously pierced, water and

blood flowed from the side, great pain was suffered, and she also "felt herself transformed into our Lord." Her stigmata were accepted as genuine gifts of God by the Inquisition, Pope Pius VII beatified her, and Gregory XVI canonized her on the 26th of May, 1839.

Anna Catharine Emmerich, a nun of Dülmen, after long previous illness, experienced full stigmatization in 1811, was repeatedly examined by the authorities, endured great pain, and always emitted blood on Fridays. The same thing is affirmed of Maria von Mörl, at Kaltern, in southern Tyrol, who after illness received the stigmata in 1833. More than forty thousand visitors went to see them. Maria Domenica Lazzari, of Capriani, is said to have borne the marks of Christ's passion on her forehead, hands, feet, and side from 1834 until 1850, and to have felt from them the most terrible physical pain.

Palma d' Oria, an Italian woman of sixty-six, visited by Dr. Imbert Gourbeyre in 1871, is or was confessedly another diabolically tormented, angelically visited individual, and was also an expert *prestidigitateuse* whose performances were too blasphemous and shocking to be used for purposes of scientific information. Her stigmata left no scars to indicate the places whence the blood had flowed. She insisted that she had not eaten anything for seven years, but had been obliged to drink a great deal because of the fierce internal heat which consumed her. This was so intense that the water swallowed was ejected at boiling temperature.

The latest and most celebrated instance of stigmatization is Louise Lateau, born in the deepest poverty at Bois d'Haine, Belgium, January 30, 1850. Chlorotic, unhealthy, and hysterical from childhood, subject to visions of saints and the Holy Virgin, and wont when in ecstasy to utter very edifying things of poverty, charity, and the priesthood, her stigmatizations have occurred after passing through her paroxysms. On Fridays she bled from the left side of her chest, blood escaped from the dorsal surfaces of both feet, and from the dorsal and palmar surfaces of both hands. Finally, other points of exit appeared in the forehead and between the shoulders. In her seizures she was insensible to all external impressions, and acted the passion of Jesus and the crucifixion. She also declared that she did not sleep, had not eaten or drunk for four years, and that the ordinary excretory processes of the body had been wholly suppressed.

America, of course, can not be excluded from the list of the lands of wonders. Fortunately, it presents but one example of the stigmatized. This is said to be Vitaline Gagnon, in the diocese of Quebec, a young woman whose early piety was demonstrated by the repetition of *Ave Marias* among the tombs, and who loved the souls in purgatory so much that they often made themselves vis-

ible to ask for the benefit of her prayers. On making her profession as a member of the *Sœurs Grises* at Ottawa she received the stigmata. Since then she had bled every Friday, suffered terribly, taken no nourishment, exhaled perfumes from her wounds, offered all her sufferings for souls in purgatory, is stout of body, and shows signs of perfect health.

Are the stigmata miraculous, or may they be accounted for on pathological principles? Two answers are given to this question. The first is purely theological, or rather ecclesiastical; the second is purely scientific. Mediæval ecclesiasticism affirms them to be miraculous; science maintains that they are natural. Roman Catholicism holds them to be miraculous, but does not make it an article of faith that all its adherents must believe. The Franciscan friars. and also the majority of Roman Catholics, fervently believed and stoutly insisted that the stigmatization of Francis Bernardone was miraculous. Dean Milman says that this almost became the creed of Christendom. "The declaration of Pope Alexander, the ardent protector of the mendicant friars, imposed it almost as an article of the belief." Nicholas IV, who was himself a Franciscan, asserted the stigmata of St. Francis; a papal bull in 1255 vindicated the claims of the miracle; and Pope Benedict XI set apart the 17th of September of each year as the feast of the Holy Stigmata. The Dominicans, irreconcilable rivals of the Franciscans, represented the whole affair as an imposture invented to raise the credit of their competitors for papal and popular favor. The Bishop of Olmutz denounced the alleged miracle as irrational. The Dominican, Jacob de Voragine, did not deny the fact of the stigmata, but assigned five causes for them. All resolve themselves into the first, which is imagination. Petrarch, Cornelius Agrippa, etc., attributed the stigmatization of Bernardone to his glowing fancy, or to an excited imagination acting on a body enfeebled by sickness and religious mortifications.

As for Palma d'Oria, after reading Dr. Hammond's relation of her absurd impostures, it is difficult not to conclude with him that she was syphilitic, strongly hysterical, the subject of *purpura hæmorrhagica*, and "a most unmitigated humbug and liar."

Neander adopts the theory of Voragine, and thinks that the story of the stigmata of Francis of Assisi sprang "from the self-deception of a fanatical bent of the imagination, and from fancied exaggeration." His language is that of the true philosophic scientist. The phenomena, whatever they were, in the case of St. Francis should be studied in the light of his character. As a youth he was vain, gay, and prodigal; of ethical education so neglected and perverse that after his reformation he did not scruple to steal from his father in order that he might repair the dilapidated church of St. Damian. Regarded alike by his neighbors and by

Innocent III as a madman, and undoubtedly half-crazy and fanatical, he pretended to the gifts of prophecy and miracles. Beggar and nurse of lepers, pious and beneficent, he was still so deficient in moral sense as to set filial duty and parental authority at defiance, and to lure three imaginative sisters of rank and fortune into a life similar to his own. Ascetic, unnatural, and a devotee, he approached so near to utter insanity that the Mohammedan Sultan of Egypt, whom he essayed to convert to his Christianity, was fully warranted in tenderly dismissing him as a lunatic. Blameless, gentle, loving, and fondly pantheistic in sentiment, his energies were wholly consecrated to the support of the endangered papacy, and the establishment of its claims against all dissenters. Such a miracle as that he affirmed would, in a grossly superstitious age, be a patent aid to him in his work. Great good and no small evil were blended in one and the same man; good that voiced itself in many memorable sayings, and induced him to conceal what he himself seems to have doubted—the marks on his hands by covering them with his habit, and on his feet by wearing shoes and stockings. There is no known limit to human credulity, and particularly in an age so illiterate and unscientific. The ecclesiastics had an adequate motive in their claim to complete dominance over the human race for bolstering up his pretensions, and for elevating the abnormal experiences of a kindly monomaniac to the rank of a miracle. Not less powerful is the motive that Belgian ecclesiastics have for upholding the claims of Louise Lateau, whose personal reward is in notoriety, rich presents, and the lavish praises of wily or superstitious advisers.

Modern medical science asserts the naturalness of the stigmata. In harmony with Neander's suggestion, it looks upon the story of St. Francis, of Lateau, and of others, as one "with regard to which it still needs and deserves inquiry to what extent, in certain eccentric states of the system, a markedly overexcited fancy might react on the bodily organism." The closest attention has been paid to Louise Lateau. M. Warlomont, commissioned by the Royal Academy of Medicine of Belgium to examine her, accompanied by several friends, made a careful examination of her person. The subject went through her regular programme. At six o'clock on Friday morning blood was freely flowing from all the stigmata. Then, as also at other times, there was no apparent external excitation of the hæmorrhage. The blood effused was of normal character, excepting the excessive amount of white corpuscles. So far, all seemed to be genuine. She did, however, when closely questioned, confess to short periods of forgetfulness at night. A cupboard in her room contained bread and fruit, and her chamber communicated directly with the yard at the back of the house. M. Warlomont concluded that the ecstasies and stig-

matizations were real, and that she ate, drank, slept, etc., like other mortals. Closely watched and deprived of food as the poor little fasting Welsh girl, Sarah Jacob, was, she would as certainly die. Even Dr. Tanner could not indefinitely resist so great a drain on vital force. Outraged nature would put further maltreatment beyond power of infliction.

Dr. D. H. Tuke, in his "Influence of the Mind upon the Body," adduces numerous instances of the fact that intense sympathetic attention to the physical injuries or pains of another produces similar phenomena and experiences in the sympathizer. Medical men show the connection between skin-diseases and nervous derangement. *Urticaria*, or hives, in children is the effect of emotional disturbance. In the disease known as *purpura hæmorrhagica*, Dr. Hammond states that "the blood is deficient in red corpuscles, while there is an increase in the white globules. . . . The affection is further characterized by a tendency of the blood to transude through the coats of the vessels." Boerhaave relates the case of a young girl who had *ampullæ*, or dilatations resembling little jugs, on various parts of her body, from which the blood flowed copiously, and which then, like those of Palma d' Oria, closed up without leaving any trace. Similar examples, more or less striking, are well known to dermatologists. From these deposits of blood in weakened, hysterical subjects, hæmorrhages follow closely on the occurrence of strong emotion. Thus Francis of Assisi, Louise Lateau, and others, thoroughly excited by passionate devotion and desire to exhibit the stigmata—where such exhibition has been the dominant idea, and the momentary expectation of its outbreak has been entertained—have unconsciously so directed the currents of nervous energy that the very phenomena desiderated have become visible. There may not have been anything but a remote correspondence between these phenomena and the wounds of the Redeemer, but extravagant fancy would at once ignore the discrepancy. Superstition always believes what it wants to believe, and the common experience of humanity is that each individual can usually behold what he desires to see. Deceivableness is one of the qualities of the human race. Dr. Hammond quotes as the counterpart of the so-called miraculous instances of the stigmata from Dr. Magnus Huss, of Stockholm, Sweden, as cited by M. Bourneville, the case of Maria K——, a servant-girl, aged twenty-three, from whose skin the blood oozed in various places after emotional disturbance. "When the exuding surface was examined with a lens, no trace of excoriation of the skin was discovered. . . . The most careful inspection failed to show any sign of a cicatrix." She naturally became the object of great curiosity, and, finding that she could cause the phenomena to take place at will, frequently produced the hæmorrhage desired

by seeking the excitement of a quarrel with some other patient. Without such assistance, she could also, by the mere effort of will, produce the mental condition from which the bleeding resulted. There is an "absolute identity in all essential respects of the cases of Maria K—— and Louise Lateau," and, it may be added, of Francis Bernardone and all other stigmatists. Many other instances like that of Maria K—— are mentioned by dermatologists.

The stigmata are worthless except as proving the influence of the mind over the body, and in this influence the power of thought, affection, and will upon its nutrition, force, and availability for service, or the contrary. They prove nothing in favor of Christianity as divine, nor of the superiority of one form of Christianity over another, or over any system of religion and ethics. They unquestionably prove nothing in favor of the moral excellence of the subjects, and certainly not that the stigmata of Francis were, as the popes declared, "the special and wonderful favor vouchsafed to him in Christ." He was not, even in later years, an ideally good man; Lateau is not of the loftiest character; Palma and the Stumbele woman were vile, and the Swedish girl utterly unscrupulous. The stigmata are useful, if useful at all, simply because they furnish material for scientific investigation, and because they warn against the dangerous material and moral conditions under which such abnormal phenomena become possible. The "Liber Conformitatum" and many other volumes exemplify the tendencies of ignorant superstition. Francis was exalted above Christ. His worship in prayer and in picture vied with that of the Redeemer. Indignant reaction from the degrading absurdity was attended by the bitterest satire and the rudest burlesque, and wrought fearful damage alike to reason, religion, and good morals.

Truth is only for those who supremely desire it. Belief, if not faith, is largely a matter of inheritance, of education, of circumstance, of preference, of will. In the debate which followed the presentation of M. Warlomont's report to the Royal Academy of Medicine of Belgium on the subject of Louise Lateau, the opinions of the speakers were in agreement with their predilections. "M. Lefebvre held to his view of miracle in the case, and M. Crocq declared that it did not pass beyond the category of pathological occurrences." Finally, the Academy decided to have nothing more to do with the matter.

Concerning the relative value of classical and modern language studies, Prof. Seeley thinks that much depends on how far the classical method is pursued, whether it be first rate or not. For persons intended for an early apprenticeship to active life and business, a good knowledge of English and of modern languages may be made a much more effective instrument of culture than the very bad knowledge of Latin and Greek which is all that they usually acquire.

HELIOTROPISM: THE TURNING MOTIONS OF PLANTS.

By CONWAY McMILLAN.

AS its derivation would indicate, heliotropism means "turning toward the sun," and is the technical name applied to all such phenomena in the vegetable kingdom. It was well known to the ancients that plants exhibited a remarkable sensitiveness to light, for Aristotle mentions it, and indeed, in its more apparent forms, it is conspicuous even to the *naïve* observer of to-day. The sunflower, or *tournesol*, as the French name it, follows the daily course of the sun with its disk-like inflorescence; plants, potted and placed in a window, bend toward the light, unless, perchance, the plant is an ivy, in which case it bends away from the source of illumination; trees and shrubs in the edge of a thicket or forest may be seen to slant toward the open, and in general it may be said that there is scarcely a plant which does not respond more or less distinctly to the directive action of light. Exceptions, as shown by Darwin and by Edouard Morren in his treatise on insectivorous plants, are for the most part carnivorous species like *Dionea*, *Drosera*, and *Nepenthes*—the Venus's-flytrap, sundew, and pitcher-plant, respectively—and twining plants. The reason why these plants should not fall under the rule will be apparent when the uses of heliotropism are discussed. Parasitic and the so-called saprophytic plants of the lower orders—those which live upon once-living matter—are commonly insensible to heliotropic stimulus, and, in short, all plants devoid of the great light-product—chlorophyl—manifest in this direction either weak irritability or none at all.

Heliotropism, it must be remembered, is not confined to plants as individuals, but is manifested by the different organs in varying degrees. Tendrils, for example, are either distinctly heliotropic, or far more commonly apheliotropic, as Darwin calls it—that is, negatively heliotropic; leaves are transversely or diaheliotropic—in other words, they tend to place themselves perpendicularly to the incident rays; stems, flower-peduncles, even roots, each in its own way, reply to the stimulus of lateral light. In passing, it should be mentioned that a plant has but one way of responding to conditions without, and this is by curvature. Even the sleep of leaves, the spontaneous movements of the sensitive-plant, or of that singular pulse, the *Hedysarum gyrans*, in which the two lateral leaflets keep up an incessant jerking motion; the reaction to a cut, bruise, or wound of any kind—as may be seen in an injured tendril; the effect of ether or chloroform, and indeed of natural forces such as electricity, gravity, or heat-vibrations, is in every

case a modified curvature. This is the one way which a plant has of reacting to the external world. Motile organisms, as, for instance, the microscopic swarm-spores of *Hæmatococcus* or *Botrydium*—a couple of fresh-water algæ—may seem to stretch the strict interpretation; but their movements may be considered under the law if one remembers that they are free, solitary cells, and must act accordingly.

Twining plants are, perhaps, the most interesting examples of an-heliotropic irritability, for their habit of growth—by no means leaving the instinctive circumnutation of the tip out of account—is a manifestation of insensibility to light. The morning-glory is a perfect example. Regardless of the sun, it twines regularly along its support, never for a moment being deflected or turned aside through conditions of unequal illumination. Of the same thing the wistaria is an equally instructive illustration. It may be safely presumed that, originally, twining plants were not twining plants at all, but were creeping in their habits; and from this it seems probable that heliotropism was once present, but is now lost. In its first appearance the habit of twining must have been accidental, and just how heliotropic tendencies were overcome by the newly developed trait is difficult to explain. It is interesting to notice, however, that the shoot of the morning-glory, when it first peeps from the ground, is distinctly heliotropic, and this must be considered an embryonic feature significant precisely as the branchial development of the fœtal mammal is significant—that is, there is indicated by it a line of descent.

A distinction must first be made between the periodic movements of leaves and stems and the true heliotropic movements. As pointed out by Dr. Julius Sachs, the first—such as the well-known phenomenon of sleep—are dependent upon the intensity of illumination, while the second are almost entirely due to the direction from which the rays chance to be falling upon the plant. It will be indispensable to a clear comprehension of what true heliotropism is to speak somewhat generally of light-action in vegetable physiology.

There is certainly no more important agent in the whole system of Nature than light. It is only in light that green plants can form their chlorophyl, and, since this chlorophyl is absolutely essential in the assimilating processes, its importance can be conceived. Even chlorophylless plants—the fungi and slime-molds—and all animals are indirectly dependent, as is well known, upon the possibility of chlorophyl-formation. The whole organized world, then, depends upon light as one of its essentials, for undulations of the ether are necessary to the well-being of all protoplasm. But not only does protoplasm react to these undulations, in very many instances, by the elaboration from itself of the

obscure carbon compound we call chlorophyl—it also manifests what is named *irritability*. This irritability is a property of all living things, and is what distinguishes them from lifeless things. It is the one great difference between a monad and a crystal. Not only in the presence of light is irritability manifested by a living creature, but also when the influence of any other natural force is felt. It is, however, only with light that we have to do at present.

Perhaps, in the whole field of biological science there is not a more obscure subject than this very one of protoplasmic irritability. Dutrochet follows the older botanists when heliotropism is presented for his consideration, and attributes the whole phenomenon to the creative intelligence behind the organism. Now Hartmann, the great German pessimist, following in the footsteps of his master, Arthur Schopenhauer, attributes the twining of the wistaria and the bending away from light of the ivy-shoot to an unconscious will in nature; and teleologists like Paley or Martineau would make the whole field a basis for argument. To be compelled to call upon the first cause for what unquestionably lies within the domain of secondary causes is, of course, no less or more than a confession of ignorance, and one which the modern worker in science is always undesirous of making. Without forgetting that Newton showed himself both a great scientist and a great philosopher when he spoke of himself as but an explorer of the sea-shore while an ocean of undiscovered truth lay beyond, it seems certain that some scientific knowledge of irritability is possible. As Sachs defines it, "it is the mode of reaction to stimuli which is peculiar to living organisms." It is what Herbert Spencer had in mind when he defined life as a continual adjustment between internal and external relations; it is what Brooks has in mind when he calls life "education," and what Haeckel calls attention to when he describes life as "memory." Irritability is really, it would seem, little more than a tendency to abandon an unstable for a stable equilibrium, and may be compared to the tendency to fall which a complicated structure of blocks, for instance, will exhibit upon the slightest disarrangement of any of its components. While the manifestations of irritability are by no means conditioned upon protoplasm alone, they always have their origin in this compound. Mechanical structures of cell-wall and cell-contents act their part in modifying, transmitting, or translating the original impulse; but this impulse itself is a characteristic of protoplasm. Sachs compares the state of things in a plant-cell, before stimulus is applied, to the state of things in a locomotive upon the throttle-valve of which the engineer's hand is placed. A slight expenditure of force will set in motion a vast quantity of matter and may liberate a totally disproportionate amount of energy.

This is evidently—in the plant-cell just as in the engine—because things are in the condition to react to slight stimulus. Thus, when a ray of light falls upon a motile swarm-spore, and it swims toward the illuminated side of the drop of water in which it is confined, the undulations of the ether may be held to have caused a more or less continuous change in the molecular structure of the protoplasm; energy is liberated, and ciliary motion in a certain direction is the final resultant. In the same way, when the sun rises in the morning, rays fall upon the stems of the sunflowers, intimate structural changes take place in the cell-protoplasm, and, through mechanical contrivances which will be mentioned later, a slow curving toward the light is effected.

This remarkable instability of protoplasm—and the writer craves the privilege of considering it only as a chemical compound of astonishing complexity—is of deep interest when considered in its relation to *growth*. Upon this something must be said. The growing part of a plant is, as we know, only the living part. Heart-wood is always dead wood, and is incapable of reacting to the external world except as unorganized matter might. Furthermore—and this need scarcely be mentioned, since the rudiments of botanical knowledge have become so wide-spread—the whole mass of living, growing tissue is made up of cells more or less crowded together, more or less individual in their forms and functions, but all of the same general plan of structure. If one could imagine the Capitol-dome at Washington completely filled with a densely crowded mass of toy balloons, each balloon distended with water, and containing within the water, usually surrounding most of it, a sac-like piece of sponge, it will be a fair idea of what a growing-point would be like if seen upon a sufficiently large scale. The phrase "growing-point" will be understood to have the technical significance, meaning the extreme tip or apical area of a bud or shoot. Each cell-wall contains its cell-sap, or cell-fluid, and its cell-protoplasm, which was compared to the sponges. The protoplasm is, of course, the only essential living part, and the others are but elaborations and mechanisms by which the complicated cell-life, as part of an organic whole, is possible. Or the appearance of a growing-point might be compared to the mound of small bubbles which may be blown in a bottle half filled with suds. Hundreds of bubbles, each full to bursting of air, press each other in every direction, and constitute a more or less conical and coherent mass of bubbles. It is here that the important point is to be noticed—

Growth is possible only when the cells are in a state of tension.

As one may easily discover, a flabby leaf will not increase in size, and a limp and flaccid stem is equally incapable of growth. In other words, growth of a plant-cell is like the growth of a bal-

loon at the gas-works. No increase in size is possible without increase of the internal pressure. Turgescence, as the state of tension is called in plant physiology, depends upon the amount of liquid in the cells, and may be regulated by the protoplasm. Indeed, a leaf may be strangled as readily as an animal which is taken by the throat. If one ties a string tightly around the petiole, water evaporates from the blade, and can not be supplied from below in sufficient quantities to keep the cells tense and elastic. Consequently, the whole leaf relapses into a state of flabbiness, and growth is impossible. Remembering, then, that growth of cells, and consequently of cell-tissue, is an unheard-of thing without turgescence, hydrostatic pressure, or, in a word, *stretching*, let us see what effect light has upon the condition of things within the plant-cell.

Although experiments along these lines are difficult to make, and, when made, difficult to interpret, it is the opinion of most botanists that the effect of light upon growth is one of retardation rather than of acceleration. It is true that plants will not thrive in darkness, but that is due to cessation in the assimilating processes. This is a comparatively clear case, and may be tested by experiment. Let a potato-tuber be cut in halves, each half containing one or more buds, or "eyes," and then let one half be allowed to sprout in darkness, while the other is brightly illuminated. Conditions of temperature and moisture should be precisely the same in each case. What, then, will be the result? Simply this: After a certain period, the length of which may vary from a day or two to more than a week, each half of the tuber will sprout, put forth a shoot, and upon this shoot there will be developed leaves. The two shoots will, however, be unlike. The one grown in light, or under normal conditions, will be short, plump, firm, green in color, and will bear well-developed green leaves. The shoot grown in the dark—the etiolated shoot, as it is technically named—will be long and slender, the leaves will be smaller, and in neither leaves nor shoot will there be a healthful green color. In other words, light seems to contribute to the production of a shorter shoot, and darkness to a longer. As to the growth of leaves, which are the assimilating organs of the plant, it is natural to suppose that in darkness they would be smaller; and such, in fact, is shown to be the case by the experiment with the potato. Having less to do, and less to do with, than leaves grown under normal conditions, they are correspondingly smaller and weaker. Microscopic examination of the two shoots will show furthermore that the fundamental tissue-cells in the etiolated shoot are much thinner-walled than in the normal shoot. In brief, the cells are *stretched* more tightly by the contained protoplasm when free from light than they are when exposed to its influence.

Perhaps these phenomena of growth-retardation in light are partly the result of dispersion of energy. In light there is heliotropism with other forms of irritability, chlorophyl-making, assimilation, and growth; while in darkness there is but response to the influence of gravity and growth. Buds which contain a definite amount of stored-up energy will, perhaps, bring to pass different results, as the number of uses made of this energy may vary. Nature is constantly performing experiments along these lines which indicate such a probability. The alternation of day and night presents a natural periodic etiolation of most normally situated plants. Examination will show that growth is more rapid in darkness than in light, and in many plants it is only at night that any considerable increase of size takes place. Some plants, like the hop—which chances to be apheliotropic—do not grow more rapidly in darkness, and this may be attributed to a difference in irritability, or perhaps an inhibition of the growth process by some other. At night, however, the temperature is lower than in the daytime, and this is inimical to growth. Again, some flowers open only at night, and since the opening of a flower is evidence that growth is retarded, another apparently abnormal case is offered. Such instances are unusual and poorly understood. In general, darkness seems to favor a maximum of turgescence in plant-cells.

Motion, now, in plants is a phenomenon of growth—not, very possibly, of growth, viewing the plant as a whole, but considering the cells separately. The sunflower turns to the sun because, upon the side next the source of illumination, the cells possess a kind of irritability, in view of which, through molecular changes in the irritated protoplasm—making it more absorbent—growth is retarded and curvature ensues. The old theory of De Candolle differed from this in that light was supposed to be inimical to nutrition, or cell-formation, and the meaning of turgescence and of irritability was not clearly understood. The ivy, which turns away from the sun, may possibly be accredited with a different kind of irritability, or, what seems more reasonable, habit may act as an inhibitor.

With regard to simple cells, the terms of the law that heliotropism is a phenomenon of growth must be modified a little. The *Bacterium photometricum* of Engelmann, which moves only under the influence of light, does not at the same time increase in size. Neither do the filaments of the *Oscillaria* nor the zoöspores of algæ. The plasmodia of slime-molds, which, except during the spore-forming stage, are negatively heliotropic, do not grow while turning from the light. Irritability in these organisms is translated at once into ciliary or mass movement, and has to do with growth only in a secondary way. It is, however, clearly

analogous in the molecular changes, and need not be considered apart. The mechanism is different, though the forces are the same; just as steam is the same, whether it runs a rolling-mill or a locomotive.

The chemical or molecular theory of light-action is greatly strengthened by two considerations: The first is, that a latent period, after stimulus and before reply, can be detected in almost every case. This, as evidence of chemical action, is conclusive. Second, the researches of Wiesner, and especially those of C. M. Guillemin, recorded in the "Annales des Sciences Naturelles," series iv, vol. vii, in which careful investigations are made into the kind of light which has the greatest effect in heliotropism, must be noted. With regard to assimilation—as we should indeed expect—the yellow rays are found to be the most favorable; but when light is studied with reference to irritability, the results are entirely different. The maxima of action are now found to be at the extreme ends of the spectrum; the ultra-red and the ultra-violet or so-called actinic rays seem to be the ones best capable of giving the necessary stimulus. The minimum is found to be in the blue, near the "F" line. That this "division of labor," as it were, among the light-rays, should be so evident and so constant, offers strong testimony in favor of the theory that irritability and assimilation are equally molecular in their nature (if we may use such an expression), and the whole hypothesis seems unusually clear and satisfactory.

To return for a moment, now, to the potato-shoot grown in darkness, one other peculiarity besides those mentioned might have been noticed. That was this: the angle between leaves and leaf-axis, or stem, was always more acute than in the normally grown plant. The whole etiolated shoot seemed to be straining toward the light. Kraus believed that this was due to imperfect anatomical development in the fibro-vascular bundles; but such a view is scarcely confirmed by the facts, for etiolation is concerned not with the fibrous system alone, but with the fundamental. Rauwenhoff supposed the vertical position of shoots grown in darkness attributable to absence of heliotropism, and the consequent unmodified action of another force in plant-physiology, namely, negative geotropism, or, more clearly, "negative gravity." This is a kind of irritability, in view of which plant-shoots tend to increase in length in a direction opposite to the terrestrial attraction. This, he thought, might be favored by the feeble thickening of the cellular tissues. In this Sachs is inclined to support Rauwenhoff; but it seems probable that the whole matter will have to be laid at the door of heredity. The plant which has always struggled upward to the light will continue to do so when placed in darkness, and all its efforts will be concentrated upon

this one end. Leaf-formation will be scanty; assimilation will be suspended; and the whole organism will reach out for the sunlight, as thousands of generations had done before its own life. That fungi of the mushroom type—needing no light, for they make no chlorophyl—reach upward too—and it is undeniably true that they elongate more rapidly in darkness—is to be considered as evidence of descent from an alga stock, and this is rendered probable by morphological as well as by this interesting physiological consideration. Heredity may come into play here as well as it does in the case of the moss antherozoids, which are attracted by the archegonium, or in the case of the fish-mold zoöspores, which swim toward decaying fish or putrid extracts of meat.

From all this, the meaning of heliotropism in the natural order of things becomes apparent. The phenomena which have been studied fit into the evolution theory as if made for the theory and not the theory for them. Plants which must have light to live are impelled toward this light by their own conditions of structure. The reaching upward is sometimes almost instinctive—almost conscious, one might fancy. Knight observed a vine-leaf try first one way and then another to reach the position of best illumination—a transverse one, which is now considered to be a result of the palisade structure, and not of a peculiar kind of irritability. Dutrochet noticed the tendril of a pea trying to avoid the light, and it finally seemed to send an impulse down to the petiole, and *this* bent backward. The question of resistance is probably, however, the only one which needs to be considered as modifying plant-action in such instances.

Climbing and twining plants, as Darwin observed, have lost their heliotropism because they would be pulled away from their supports if they always followed the sun. For the same reason tendrils, aërial roots, the suckers of *Parthenocissus quinquefolia*—the Virginia creeper—are, considered as separate organs, apheliotropic rather than the reverse. Carnivorous plants, which at least partially depend for sustenance upon a peculiar position of leaves and stem, and which have less need of light for assimilation, have also lost their powers of response to the heliotropic stimulus. It must not be supposed, however, for a moment, that heliotropic irritability is not present. It may be there, and well developed too; but inhibited by heredity, by growth, by environment. Just as the compass-plant when grown in darkness allows its leaves to adopt the horizontal position, so does the Venus's-flytrap when growing normally, and it is probable that, if generation after generation of compass-plants could be grown in the darkness, the erect position of the leaves would permanently disappear. Just so the Venus's-flytrap has lost the power of responding to its heliotropic tendency, through its carnivorous habits. Vines, indeed, thinks

a different kind of irritability, or at least a conspicuous lack of the normal kind, is denoted by such habits of growth; but gravity, heredity, and anatomical peculiarities may be entirely responsible. Nor need the meaning of heliotropism in a theory of descent be seriously affected by the observations of Sachs upon certain roots which, although never normally in the light, showed marked heliotropic irritability when grown in illuminated water. In such cases a change in protoplasmic structure might easily have ensued after the change in life-conditions and before the manifestation of unexpected irritability. It is this which renders conclusions drawn from such data as Sachs had doubtful and, perhaps, fallacious.

Heliotropism, then, must be considered as a well-marked physiological trait; developed through ages of natural selection, in accordance with the laws of use and disuse, and here and there modified or altogether absent, as the needs of the organism chanced to demand. It is a result of irritability, and is usually manifested in connection with growth. As acknowledged above, it is still rather poorly understood, in its more recondite expressions; but, in general, it may justly be held to be a very complicated reaction in the department of molecular physics, or chemistry.

A FOSSIL CONTINENT.

IF an intelligent Australian colonist were suddenly to be translated backward from Collins Street, Melbourne, into the flourishing woods of the secondary geological period—say about the precise moment of time when the English chalk downs were slowly accumulating, speck by speck, on the silent floor of some long-forgotten Mediterranean—the intelligent colonist would look around him with a sweet smile of cheerful recognition, and say to himself in some surprise, "Why, this is just like Australia." The animals, the trees, the plants, the insects, would all more or less vividly remind him of those he had left behind him in his happy home of the southern seas and the nineteenth century. The sun would have moved back on the dial of ages for a few million summers or so, indefinitely (in geology we refuse to be bound by dates), and would have landed him at last, to his immense astonishment, pretty much at the exact point whence he first started.

In other words, with a few needful qualifications, to be made hereafter, Australia is, so to speak, a fossil continent, a country still in its secondary age, a surviving fragment of the primitive world of the chalk period or earlier ages. Isolated from all the remainder of the earth about the beginning of the Tertiary epoch,

long before the mammoth and the mastodon had yet dreamed of appearing upon the stage of existence, long before the first shadowy ancestor of the horse had turned tail on Nature's rough draught of the still undeveloped and unspecialized lion, long before the extinct dinotheriums and gigantic Irish elks and colossal giraffes of late Tertiary times had even begun to run their race on the broad plains of Europe and America, the Australian continent found itself at an early period of its development cut off entirely from all social intercourse with the remainder of our planet, and turned upon itself, like the German philosopher, to evolve its own plants and animals out of its own inner consciousness. The natural consequence was, that progress in Australia has been absurdly slow, and that the country as a whole has fallen most woefully behind the times in all matters pertaining to the existence of life upon its surface. Everybody knows that Australia as a whole is a very peculiar and original continent; its peculiarity, however, consists, at bottom, for the most part in the fact that it still remains at very nearly the same early point of development which Europe had attained a couple of million years ago or thereabout. "Advance, Australia," says the national motto; and, indeed, it is quite time nowadays that Australia should advance; for, so far, she has been left out of the running for some four mundane ages or so at a rough computation.

Example, says the wisdom of our ancestors, is better than precept; so perhaps, if I take a single example to start with, I shall make the principle I wish to illustrate a trifle clearer to the European comprehension. In Australia, when Cook or Van Diemen first visited it, there were no horses, cows, or sheep; no rabbits, weasels, or cats; no indigenous quadrupeds of any sort except the pouched mammals or marsupials, familiarly typified to every one of us by the mamma kangaroo in Regent's Park, who carries the baby kangaroos about with her, neatly deposited in the sac or pouch which Nature has provided for them instead of a cradle. To this rough generalization, to be sure, two special exceptions must needs be made; namely, the noble Australian black-fellow himself, and the dingo or wild dog, whose ancestors no doubt came to the country in the same ship with him, as the brown rat came to England with George I of blessed memory. But of these two solitary representatives of the later and higher Asiatic fauna "more anon"; for the present we may regard it as approximately true that aboriginal and unsophisticated Australia in the lump was wholly given over, on its first discovery, to kangaroos, phalangers, dasyures, wombats, and other quaint marsupial animals, with names as strange and clumsy as their forms.

Now, who and what are the marsupials as a family, viewed in the dry light of modern science? Well, they are simply one of

the very oldest mammalian families, and therefore, I need hardly say, in the leveling and topsy-turvy view of evolutionary biology, the least entitled to consideration or respect from rational observers. For of course in the kingdom of science the last shall be first, and the first last; it is the oldest families that are accounted the worst, while the best families mean always the newest. Now, the earliest mammals to appear on earth were creatures of distinctly marsupial type. As long ago as the time when the red marl of Devonshire and the blue lias of Lyme Regis were laid down on the bed of the muddy sea that once covered the surface of Dorset and the English Channel, a little creature like the kangaroo rats of Southern Australia lived among the plains of what is now the south of England. In the ages succeeding the deposition of the red marl, Europe seems to have been broken up into an archipelago of coral reefs and atolls; and the islands of this ancient oölitic ocean were tenanted by numbers of tiny ancestral marsupials, some of which approached in appearance the pouched anteaters of Western Australia, while others resembled rather the phalangers and wombats, or turned into excellent imitation carnivores, like our modern friend the Tasmanian devil. Up to the end of the time when the chalk deposits of Surrey, Kent, and Sussex were laid down, indeed, there is no evidence of the existence anywhere in the world of any mammals differing in type from those which now inhabit Australia. In other words, so far as regards mammalian life, the whole of the world had then already reached pretty nearly the same point of evolution that poor Australia still sticks at.

About the beginning of the Tertiary period, however, just after the chalk was all deposited, and just before the comparatively modern clays and sandstones of the London basin began to be laid down, an arm of the sea broke up the connection which once subsisted between Australia and the rest of the world, probably by a land-bridge, *via* Java, Sumatra, the Malay Peninsula, and Asia generally. "But how do you know," asks the candid inquirer, "that such a connection ever existed at all?" Simply thus, most laudable investigator—because there are large land mammals in Australia. Now, large land mammals do not swim across a broad ocean. There are none in New Zealand, none in the Azores, none in Fiji, none in Tahiti, none in Madeira, none in Teneriffe—none, in short, in any oceanic island which never at any time formed part of a great continent. How could there be, indeed? The mammals must necessarily have got there from somewhere; and whenever we find islands like Britain, or Japan, or Newfoundland, or Sicily, possessing large and abundant indigenous quadrupeds of the same general type as adjacent continents, we see at once that the island must formerly have been a mere peninsula, like

Italy or Nova Scotia at the present day. The very fact that Australia incloses a large group of biggish quadrupeds, whose congeners once inhabited Europe and America, suffices in itself to prove beyond question that uninterrupted land communication must once have existed between Australia and those distant continents.

In fact, to this day a belt of very deep sea, known as Wallace's Line, from the great naturalist who first pointed out its far-reaching zoölogical importance, separates what is called by science "the Australian province" on the southwest from "the Indo-Malayan province" to the north and east of it. This belt of deep sea divides off sharply the plants and animals of the Australian type from those of the common Indian and Burmese pattern. South of Wallace's line we now find several islands, big and small, including New Guinea, Australia, Tasmania, the Moluccas, Celebes, Timor, Amboyna, and Banda. All these lands, whose precise geographical position on the map must of course be readily remembered, in this age of school-boards and universal examination, by every pupil-teacher and every Girton girl, are now divided by minor straits of much shallower water; but they all stand on a great submarine bank, and obviously formed at one time parts of the same wide Australian continent, because the animals of Australian type are still found in every one of them. No Indian or Malayan animal, however, of the larger sort (other than birds) is to be discovered anywhere south of Wallace's Line. That narrow belt of deep sea, in short, forms an ocean barrier which has subsisted there without alteration ever since the end of the Secondary period. From that time to this, as the evidence shows us, there has never been any direct land communication between Australia and any part of the outer world beyond that narrow line of division.

Some years ago, in fact, a clever hoax took the world by surprise for a moment, under the audacious title of "Captain Lawson's Adventures in New Guinea." The gallant captain, or his unknown creator in some London lodging, pretended to have explored the Papuan jungles, and there to have met with marvelous escapes from terrible beasts of the common tropical Asiatic pattern—rhinoceroses, tigers, monkeys, and leopards. Everybody believed the new Munchausen at first, except the zoölogists. Those canny folk saw through the wicked hoax on the very first blush of it. If there were rhinoceroses in Papua, they must have got there by an overland route. If there had ever been a land-connection between New Guinea and the Malay region, then, since Australian animals range into New Guinea, Malayan animals would have ranged into Australia, and we should find Victoria and New South Wales at the present day peopled by tapirs, orang-

outangs, wild boars, deer, elephants, and squirrels, like those which now people Borneo, instead of, or side by side with, the kangaroos, wombats, and other marsupials, which, as we know, actually form the sole indigenous mammalian population of Greater Britain beneath the Southern Cross. Of course, in the end, the mysterious and tremendous Captain Lawson proved to be a myth, an airy nothing, upon whom imagination had bestowed a local habitation (in New Guinea) and a name (not to be found in the army list). Wallace's Line was saved from reproach, and the intrusive rhinoceros was banished without appeal from the soil of Papua.

After the deep belt of open sea was thus established between the bigger Australian continent and the Malayan region, however, the mammals of the great mainlands continued to develop on their own account, in accordance with the strictest Darwinian principles, among the wider plains of their own habitats. The competition there was fiercer and more general; the struggle for life was bloodier and more arduous. Hence, while the old-fashioned marsupials continued to survive and to evolve slowly along their own lines in their own restricted southern world, their collateral descendants in Europe, and Asia, and America, or elsewhere, went on progressing into far higher, stronger, and better adapted forms—the great central mammalian fauna. In place of the petty phalangers and pouched ant-eaters of the oölitic period, our tertiary strata in the larger continents show us a rapid and extraordinary development of the mammalian race into monstrous creatures, some of them now quite extinct, and some still holding their own undisturbed in India, Africa, and the American prairies. The paleotherium and the dinoceras, the mastodon and the mammoth, the huge giraffes and antelopes of sunnier times, succeed to the ancestral kangaroos and wombats of the Secondary strata. Slowly the horses grow more horse-like, the shadowy camel begins to camelize himself, the buffaloes acquire the rudiments of horns, the deer branch out by tentative steps into still more complicated and more complicated antlers. Side by side with this wonderful outgrowth of the mammalian type, in the first plasticity of its vigorous youth, the older marsupials die away one by one in the geological record before the faces of their more successful competitors; the new carnivores devour them wholesale, the new ruminants eat up their pastures, the new rodents outwit them in the modernized forests. At last the pouched creatures all disappear utterly from all the world, save only Australia, with the solitary exception of a single advanced marsupial family, the familiar opossum of plantation melodies. And the history of the opossum himself is so very singular that it almost deserves to receive the polite attention of a separate paragraph for its own proper elucidation.

For the opossums form the only members of the marsupial class now living outside Australia; and yet, what is at least equally remarkable, none of the opossums are found *per contra* in Australia itself. They are, in fact, the highest and best product of the old dying marsupial stock, specially evolved in the great continents through the fierce competition of the higher mammals then being developed on every side of them. Therefore, being later in point of time than the separation, they could no more get over to Australia than the elephants and tigers and rhinoceroses could. They are the last bid for life of the marsupial race in its hopeless struggle against its more developed mammalian cousins. In Europe and Asia the opossums lived on lustily, in spite of competition, during the whole of the Eocene period, side by side with hog-like creatures not yet perfectly piggish, with nondescript animals, half horse, half tapir, and with hornless forms of deer and antelopes, unprovided, so far, with the first rudiment of budding antlers. But in the succeeding age they seem to disappear from the Eastern continent, though in the Western, thanks to their hand-like feet, opposable thumb, and tree-haunting life, they still drag out a precarious existence in many forms from Virginia to Chili, and from Brazil to California. It is worth while to notice, too, that whereas the kangaroos and other Australian marsupials are proverbially the very stupidest of mammals, the opossums, on the contrary, are well known to those accurate observers of animal psychology, the plantation negroes, to be the very cleverest, cunningest, and slyest of American quadrupeds. In the fierce struggle for life of the crowded American lowlands, the opossum was absolutely forced to acquire a certain amount of Yankee smartness, or else to be improved off the face of the earth by the keen competition of the pouchless mammals.

Up to the day, then, when Captain Cook and Sir Joseph Banks, landing for the first time on the coast of New South Wales, saw an animal with short front limbs, huge hind legs, a monstrous tail, and a curious habit of hopping along the ground (called by the natives a kangaroo), the opossums of America were the only pouched mammals known to the European world in any part of the explored continents. Australia, severed from the rest of the earth—*penitus toto orbe divisa*—ever since the end of the secondary period, remained as yet, so to speak, in the secondary age so far as its larger life-elements were concerned, and presented to the first comers a certain vague and indefinite picture of what "the world before the flood" must have looked like. Only it was a very remote flood; an antediluvian age separated from our own not by thousands but by millions of seasons.

To this rough approximate statement, however, sundry needful qualifications must be made at the very outset. No statement is

ever quite correct until you have contradicted in minute detail about two thirds of it.

In the first place there are a good many modern elements in the indigenous population of Australia; but then they are elements of the stray and casual sort one always finds even in remote oceanic islands. They are waifs wafted by accident from other places. For example, the flora is by no means exclusively an ancient flora, for a considerable number of seeds and fruits and spores of ferns always get blown by the wind, or washed by the sea, or carried on the feet or feathers of birds, from one part of the world to another. In all these various ways, no doubt, modern plants from the Asiatic region have invaded Australia at different times, and altered to some extent the character and aspect of its original native vegetation. Nevertheless, even in the matter of its plants and trees, Australia must still be considered a very old-fashioned and stick-in-the-mud continent. The strange puzzle-monkeys, the quaint-jointed casuarinas (like horse-tails grown into big willows), and the park-like forests of blue-gum trees, with their smooth stems robbed of their outer bark, impart a marvelously antiquated and unfamiliar tone to the general appearance of Australian woodland. All these types belong by birth to classes long since extinct in the larger continents. The scrub shows no turfy greensward; grasses, which elsewhere carpet the ground, were almost unknown till introduced from Europe; in the wild lands, bushes and undershrubs of ancient aspect cover the soil, remarkable for their stiff, dry, wiry foliage, their vertically instead of horizontally flattened leaves, and their general dead blue-green or glaucous color. Altogether, the vegetation itself, though it contains a few more modern forms than the animal world, is still essentially antique in type, a strange survival from the forgotten flora of the chalk age, the oölite, and even the lias.

Again, to winged animals, such as birds and bats and flying insects, the ocean forms far less of a barrier than it does to quadrupeds, to reptiles, and to fresh-water fishes. Hence Australia has, to some extent, been invaded by later types of birds and other flying creatures, who live on there side by side with the ancient animals of the Secondary pattern. Warblers, thrushes, fly-catchers, shrikes, and crows must all be comparatively recent immigrants from the Asiatic mainland. Even in this respect, however, the Australian life-region still bears an antiquated and undeveloped aspect. Nowhere else in the world do we find those very oldest types of birds represented by the cassowaries, the emus, and the mooruk of New Britain. The extreme term in this exceedingly ancient set of creatures is given us by the wingless bird, the apteryx or kiwi of New Zealand, whose feathers nearly resemble hair, and whose grotesque appearance makes it as much a wonder

in its own class as the puzzle-monkey and the casuarina are among forest-trees. No feathered creatures so closely approach the lizard-tailed birds of the oölite or the toothed birds of the Cretaceous period as do these Australian and New Zealand emus and apteryxes. Again, while many characteristic Oriental families are quite absent, like the vultures, woodpeckers, pheasants, and bulbuls, the Australian region has many other fairly ancient birds, found nowhere else on the surface of our modern planet. Such are the so-called brush-turkeys and mound-builders, the only feathered things that never sit upon their own eggs, but allow them to be hatched after the fashion of reptiles, by the heat of the sand or of fermenting vegetable matter. The piping crows, the honey-suckers, the lyre-birds, and the more-porks are all peculiar to the Australian region. So are the wonderful and æsthetic bower-birds. Brush-tongued lories, black cockatoos, and gorgeously colored pigeons, though somewhat less antique, perhaps, in type, give a special character to the bird-life of the country. And in New Guinea, an isolated bit of the same old continent, the birds-of-paradise, found nowhere else in the whole world, seem to recall some forgotten Eden of the remote past, some golden age of Saturnian splendor. Poetry apart, into which I have dropped for a moment like Mr. Silas Wegg, the birds-of-paradise are, in fact, gorgeously dressed crows, specially adapted to forest-life in a rich fruit-bearing tropical country, where food is abundant and enemies unknown.

Last of all, a certain small number of modern mammals have passed over to Australia at various times by pure chance. They fall into two classes—the rats and mice, who doubtless got transported across on floating logs or balks of timber; and the human importations, including the dog, who came, perhaps, on their own canoes, perhaps on the wreck and *débris* of inundations. Yet even in these cases, again, Australia still maintains its proud preeminence as the most antiquated and unprogressive of continents. For the Australian black-fellow must have got there a very long time ago, indeed; he belongs to an extremely ancient human type, and strikingly recalls in his jaws and skull the Neanderthal savage and other early prehistoric races; while the woolly-headed Tasmanian, a member of a totally distinct human family, and, perhaps, the very lowest sample of humanity that has survived to modern times, must have crossed over to Tasmania even earlier still, his brethren on the mainland having, no doubt, been exterminated later on, when the stone-age Australian black-fellows first got cast ashore upon the continent inhabited by the yet more barbaric and helpless negritto race. As for the dingo, or Australian wild dog, only half domesticated by the savage natives, he represents a low ancestral dog type, half wolf and half jackal, incapa-

ble of the higher canine traits, and with a suspicious, ferocious, glaring eye, that betrays at once his uncivilizable tendencies.

Omitting these later importations, however—the modern plants, birds, and human beings—it may be fairly said that Australia is still in its Secondary stage, while the rest of the world has reached the Tertiary and Quaternary periods. Here, again, however, a deduction must be made, in order to attain the necessary accuracy. Even in Australia the world never stands still. Though the Australian animals are still at bottom the European and Asiatic animals of the Secondary age, they are those animals with a difference. They have undergone an evolution of their own. It has not been the evolution of the great continents; but it has been evolution all the same; slower, more local, narrower, more restricted, yet evolution in the truest sense. One might compare the difference to the difference between the civilization of Europe and the civilization of Mexico or Peru. The Mexicans, when Cortes blotted out their indigenous culture, were still, to be sure, in their stone age; but it was a very different stone age from that of the cave-dwellers or the mound-builders in Britain. Even so, though Australia is still zoölogically in the Secondary period, it is a Secondary period a good deal altered and adapted in detail to meet the wants of special situations.

The oldest types of animals in Australia are the ornithorhynchus and the echidna, the "beast with a bill" and the "porcupine ant-eater" of popular natural history. These curious creatures, genuine living fossils, occupy in some respects an intermediate place between the mammals on the one hand and the birds and lizards on the other. The echidna has no teeth, and a very bird-like skull and body; the ornithorhynchus has a bill like a duck's, webbed feet, and a great many quaint anatomical peculiarities which closely ally it to the birds and reptiles. Both, in fact, are early arrested stages in the development of mammals from the old common vertebrate ancestor; and they could only have struggled on to our own day in a continent free from the severe competition of the higher types which have since been evolved in Europe and Asia. Even in Australia itself the ornithorhynchus and echidna have had to put up perforce with the lower places in the hierarchy of Nature. The first is a burrowing and aquatic creature, specialized in a thousand minute ways for his amphibious life and queer subterranean habits; the second is a spiny, hedgehog-like nocturnal prowler, who buries himself in the earth during the day, and lives by night on insects which he licks up greedily with his long, ribbon-like tongue. Apart from the specializations brought about by their necessary adaptation to a particular niche in the economy of life, these two quaint and very ancient animals probably preserve for us in their general structure the features of an extremely

early descendant of the common ancestor from whom mammals, birds, and reptiles alike are originally derived.

The ordinary Australian pouched mammals belong to far less ancient types than ornithorhynchus and echidna, but they too are very old in structure, though they have undergone an extraordinary separate evolution to fit them for the most diverse positions in life. Almost every main form of higher mammal (except the biggest ones) has, as it were, its analogue or representative among the marsupial fauna of the Australasian region fitted to fill the same niche in nature. For instance, in the blue-gum forests of New South Wales, a small animal inhabits the trees, in form and aspect exactly like a flying-squirrel. Nobody who was not a structural and anatomical naturalist would ever for a moment dream of doubting its close affinity to the flying-squirrels of the American woodlands. It has just the same general outline, just the same bushy tail, just the same rough arrangement of colors, and just the same expanded parachute-like membrane stretching between the fore and hind limbs. Why should this be so? Clearly because both animals have independently adapted themselves to the same mode of life under the same general circumstances. Natural selection, acting upon unlike original types, but in like conditions, has produced in the end very similar results in both cases. Still, when we come to examine the more intimate underlying structure of the two animals, a profound fundamental difference at once exhibits itself. The one is distinctly a true squirrel, a rodent of the rodents, externally adapted to an arboreal existence; the other is equally a true phalanger, a marsupial of the marsupials, which has independently undergone on his own account very much the same adaptation, for very much the same reasons. Just so a dolphin looks externally very like a fish, in head and tail and form and movement; its flippers closely resemble fins; and nothing about it seems to differ very markedly from the outer aspect of a shark or a codfish. But in reality it has no gills and no swim-bladder; it lays no eggs; it does not own one truly fish-like organ. It breathes air, it possesses lungs, it has warm blood, it suckles its young; in heart and brain and nerves and organization it is a thorough-going mammal, with an acquired resemblance to the fishy form, due entirely to mere similarity in place of residence.

Running hastily through the chief marsupial developments, one may say that the wombats are pouched animals who take the place of rabbits or marmots in Europe, and resemble them both in burrowing habits and more or less in shape, which closely approaches the familiar and ungraceful guinea-pig outline. The vulpine phalanger does duty for a fox; the fat and sleepy little dormouse phalanger takes the place of a European dormouse. Both

are so ridiculously like the analogous animals of the larger continents that the colonists always call them, in perfect good faith, by the familiar names of the old-country creatures. The koala poses as a small bear; the cuscus answers to the raccoons of America. The pouched badgers explain themselves at once by their very name, like the Plyants, the Pinchwifes, the Brainsicks, and the Carelesses of the Restoration comedy. The "native rabbit" of Swan River is a rabbit-like bandicoot; the pouched ant-eater similarly takes the place of the true ant-eater of other continents. By way of carnivores, the Tasmanian devil is a fierce and savage marsupial analogue of the American wolverine; a smaller species of the same type usurps the name and place of the marten; and the dog-headed thylacinus is in form and figure precisely like a wolf or a jackal. The pouched weasels are very weasel-like; the kangaroo rats and kangaroo mice run the true rats and mice a close race in every particular. And it is worth notice, in this connection, that the one marsupial family which could compete with higher American life, the opossums, are, so to speak, the monkey development of the marsupial race. They have opposable thumbs, which make their feet almost into hands; they have prehensile tails, by which they hang from branches in true monkey fashion; they lead an arboreal omnivorous existence; they feed off fruits, birds' eggs, insects, and roots; and altogether they are just active, cunning, intelligent, tree-haunting marsupial spider-monkeys.

Australia has also one still more ancient denizen than any of these, a living fossil of the very oldest sort, a creature of wholly immemorial and primitive antiquity. The story of its discovery teems with the strangest romance of natural history. To those who could appreciate the facts of the case it was just as curious and just as interesting as though we were now to discover somewhere in an unknown island or an African oasis some surviving mammoth, some belated megatherium, or some gigantic and misshapen liassic saurian. Imagine the extinct animals of the Crystal Palace grounds suddenly appearing to our dazzled eyes in a tropical ramble, and you can faintly conceive the delight and astonishment of naturalists at large when the barramunda first "swam into their ken" in the rivers of Queensland. To be sure, in size and shape this "extinct fish," still living and grunting quietly in our midst, is comparatively insignificant beside the "dragons of the prime" immortalized in a famous stanza by Tennyson: but to the true enthusiast, size is nothing; and the barramunda is just as much a marvel and a monster as the Atlantosaurus himself would have been if he had suddenly walked upon the stage of time, dragging fifty feet of lizard-like tail in a train behind him. And this is the plain story of that marvelous discovery of a "missing link" in our own pedigree.

In the oldest Secondary rocks of Britain and elsewhere there occur in abundance the teeth of a genus of ganoid fishes known as the Ceratodi. (I apologize for ganoid, though it is not a swear-word.) These teeth reappear from time to time in several subsequent formations, but at last slowly die out altogether; and of course all naturalists naturally concluded that the creature to which they belonged had died out also, and was long since numbered with the dodo and the mastodon. The idea that a ceratodus could still be living, far less that it formed an important link in the development of all the higher animals, could never for a moment have occurred to anybody. As well expect to find a palæolithic man quietly chipping flints on a Pacific atoll, or to discover the ancestor of all horses on the isolated and crag-encircled summit of Roraima, as to unearth a real live ceratodus from a modern estuary. In 1870, however, Mr. Krefft took away the breath of scientific Europe by informing it that he had found the extinct ganoid swimming about as large as life, and six feet long, without the faintest consciousness of its own scientific importance, in a river of Queensland at the present day. The unsophisticated aborigines knew it as barramunda; the almost equally ignorant white settlers called it with irreverent and unfilial contempt the flat-head. On further examination, however, the despised barramunda proved to be a connecting link of primary rank between the oldest surviving group of fishes and the lowest air-breathing animals like the frogs and salamanders. Though a true fish, it leaves its native streams at night, and sets out on a foraging expedition after vegetable food in the neighboring woodlands. There it browses on myrtle leaves and grasses, and otherwise behaves itself in a manner wholly unbecoming its piscine antecedents and aquatic education. To fit it for this strange amphibious life, the barramunda has both lungs and gills; it can breathe either air or water at will, or, if it chooses, the two together. Though covered with scales, and most fish-like in outline, it presents points of anatomical resemblance both to salamanders and lizards; and, as a connecting bond between the North American mud-fish on the one hand and the wonderful lepidosiren on the other, it forms a true member of the long series by which the higher animals generally trace their descent from a remote race of marine ancestors. It is very interesting, therefore, to find that this living fossil link between fish and reptiles should have survived only in the fossil continent, Australia. Everywhere else it has long since been beaten out of the field by its own more developed amphibian descendants; in Australia alone it still drags on a lonely existence as the last relic of an otherwise long-forgotten and extinct family.—*Cornhill Magazine.*

SKETCH OF CARL FRIEDRICH GAUSS.

"IF we except the great name of Newton," says Prof. H. J. S. Smith, "it is probable that no mathematician of any age or country has ever surpassed Gauss in the combination of an abundant fertility in invention with an absolute rigorousness in demonstration which the ancient Greeks themselves might have envied." Wagener says, in the sketch of Gauss in the "Biographie Universelle," that each work of his is an event in the history of science, a revolution, which, overturning the old theories and methods, replaces them by new ones, and advances science to a height which no one had ever before dreamed of. The scientific estimate of Gauss's quality took another form in the expression of Laplace, who, when asked who was the greatest mathematician in Germany, replied "Pfaff." His interrogator remarking that he should have thought Gauss was, Laplace retorted, "Oh, yes, Pfaff is the greatest mathematician in Germany, but Gauss is the greatest mathematician in Europe."

CARL FRIEDRICH GAUSS was born in Brunswick, April 23, 1777, and died in Göttingen, February 23, 1855. His father was a brick-layer, and desired that the boy should be brought up to the same trade. But the lad had other tastes, and is said by some of his biographers to have displayed a greater precocity in his aptitude for mathematics than even Pascal. At three years old he could calculate and solve problems in numbers, and amuse himself by tracing geometrical lines and figures in the sand. He had, in fact, hardly reached that age when he ventured to tell his father concerning a certain account, "That is not right; it should be so much" —and was correct. At the age of ten he was acquainted with the binomial theorem and theory of the infinite series. Such gifts could not fail to attract marked attention from his teachers. The report of them reached Bartels, afterward Professor of Mathematics at Dorpat, and he brought the youth to the notice of Charles William, Duke of Brunswick, who undertook the charge of his education. Having, rather in opposition to his father's designs, learned all that the professors at the Collegium Carolinum could teach him, he went to Göttingen, in 1795, "as yet undecided whether to pursue philology or mathematics." The scale was probably turned by circumstances; one of them, perhaps, being the rare gifts of the mathematical professor, Kaestner, whom Gauss described as the "first of geometers among poets, and the first of poets among geometers"; and another, his success in solving the problem of the division of the circle into seventeen equal parts. Henceforth he made mathematics, which he styled "the queen of the sciences," the main study of his life, interesting himself par-

ticularly in arithmetic, "the queen of mathematics." After completing his course at the university, Gauss spent a short time in 1798 at Helmstadt, consulting the library there, and enjoying the society of his fellow-mathematician Pfaff. Having obtained a full supply of notes, he returned to Brunswick, and employed himself in the elaboration of the studies which have placed his name high in the list of eminent mathematicians.

In 1807 he was offered by the Czar of Russia a professorship in the Academy of St. Petersburg; but he declined the position, at the instance of Olbers, and because he felt that such a professorship would cramp his studies. His desire was to obtain the post of astronomer at an observatory, so that he could spend all his time on his observations and his studies for the advancement of science. This desire was gratified in the same year, when he was appointed Director of the Observatory and Professor of Astronomy at Göttingen. In this service he spent the rest of his life, never sleeping away from under the roof of the building, except in 1828, when he accepted an invitation to attend a meeting of the natural philosophers in Berlin, and in 1854—the year before his death—when, on the opening of the railway to Hamburg, he for the first time saw a locomotive. He consecrated all his time, says Larousse, "his genius, and his indefatigable activity, to the most abstract and profound researches in all branches of mathematics, astronomy, and physics. Endowed with most favorable health, possessing simple and modest tastes, so indifferent to display that he never wore any of the numerous decorations that the various governments decreed to him, Gauss had a gentle, upright, and correct character. Applying the greatest care to the preparation of his briefest as well as of his most elaborate memoirs, he would offer nothing to the public till it had received the last finishing touches from the workman's hand. He had engraved on his seal a tree loaded with fruit, encircled with the legend, '*Pauca, sed matura*' (few, but ripe). And he left a large number of works, which he did not consider mature enough to publish," but which arrangements were made after his death for having edited. "The genius of Gauss," Larousse continues, "was essentially original. If he was treating of a subject which had already engaged the attention of other students, it seemed as if their works were wholly unknown to him. He had his own manner of approaching the propositions, and his own method of treating them, and his solutions were absolutely new. These solutions had the merit of being general, complete, and applicable to all the cases that could be included under the question. Unfortunately, the very originality of the methods, a particular mode of notation, and the exaggerated, perhaps affected, laconicism of his demonstrations, make the reading of Gauss's works extremely

laborious. Hence, envious minds have not let the opportunity pass to reproach him with having made himself unintelligible in order to appear profound. The reason of this is, that Gauss does not leave visible any trace of the analytical course by which he has been led to the final solution. He used to say that when a monument is exhibited to the public there should remain no traces of the scaffoldings that have been used in constructing it. He was wrong in this; for, although it may be true that the scaffoldings ought to be withdrawn from the eye of the public, they should be for a certain time accessible to those of architects; and, even if they are out of use, they are sometimes the object of special descriptions, which make their merit understood. . . . Although Gauss is hard to understand as a writer, he was very clear as a professor. He was not, however, one of those mathematicians who are represented as being so deeply buried in their science as to have become strangers to the outer world. He used to talk pertinently and agreeably on subjects of philosophy, politics, and literature."

The charge of obscurity here brought against Gauss is reviewed by Prof. H. J. S. Smith, who says: "It may seem paradoxical, but it is probably nevertheless true, that it is precisely the effort after a logical perfection of form which has rendered the writings of Gauss open to the charge of obscurity and unnecessary difficulty. The fact is, that there is neither obscurity nor difficulty in his writings, so long as we read them in the submissive spirit in which an intelligent school-boy is made to read his Euclid. Every assertion that is made is fully proved, and the assertions succeed one another in a perfectly just analogical order; there is nothing, so far, of which we can complain. But, when we have finished the perusal, we soon begin to feel that our work is but begun, that we are still standing on the threshold of the temple, and that there is a secret which lies behind the veil, and is as yet concealed from us. . . . No vestige appears of the process by which the result itself was obtained, perhaps not even a trace of the considerations which suggested the successive steps of the demonstration."

According to M. Wagener, as summarized by Prof. Tucker, though Gauss looked upon mathematics as the principal means for developing human knowledge, he yet fully recognized the beneficial influence of an acquaintance with classical literature. He had, indeed, a wonderful faculty for the acquisition of languages; he was acquainted with most of the European languages, and could speak many of them well. At the age of sixty-two he took up the study of the Russian language, and he mastered it in two years. He took a great interest in politics till within a few weeks of his death. "His lectures, in which he adopted the ana-

lytic method, were exceedingly clear expositions; in them he liked to discuss the methods and the roads by which he had arrived at his great results. He required the closest attention, and objected to the taking of notes, lest his hearers should lose the thread of his argument. The students seated round the lecture-table listened with delight to the lucid and animated addresses of their master; addresses more resembling conversations than set lectures."

Gauss's writings are upon subjects of arithmetic, algebra, and astronomy. The fullest list, that given in the Royal Society's catalogue of scientific papers, contains one hundred and twenty-four titles, but does not include his largest works. The most important papers are on arithmetic, while only a very few of the number are algebraic, and they all relating to a single theorem. Prof. Cayley remarks that of the memoirs in pure mathematics "it may be safely said that there is not one which has not signally contributed to the progress of the branch of mathematics to which it belongs, or which would not require to be carefully analyzed in a history of the subject." One of his earliest discoveries was "the method of least squares," which, though first published by Legendre, he applied as early as 1795. His first published paper—a thesis for the Doctorate of Philosophy, in 1799—was devoted to the demonstration that every equation has a root; and of this theorem he made two other distinct demonstrations in 1815 and 1816. But these works, though he was the first in the field on the subject, gave him no fame. Lagrange seems not to have heard of the first one; and Cauchy, whose subsequent demonstrations have been preferred, received in France all the praise due to a first discoverer. The "Disquisitiones Arithmeticæ," which is perhaps his principal work, contains many important researches, one of which, known as the celebrated Fundamental Theorem of Gauss, or the law of Quadratic Reciprocity of Legendre, of itself alone, Prof. Tucker says, "would have placed Gauss in the first rank of mathematicians." The author discovered it by induction before he was eighteen years old, and worked out the first proof which he published of it in the following year. He was not satisfied with this, but published other demonstrations resting on different principles, till the number reached six. He had, however, been anticipated in enunciating the theorem, but in a more complex form, by Euler, and Legendre had unsuccessfully attempted to prove it. "The question of priority of enunciation or of demonstrating by induction," says Prof. Tucker, "in this case is a trifling one; any rigorous demonstration of it involved apparently insuperable difficulties." Another discussion involves the theory of describing within a circle the polygon of seventeen sides; another, the theory of the congruence of numbers, or the relation that exists between

all numbers that give the same remainder when they are divided by the same number. In his "General Disquisitions on Curved Surfaces," he established the famous theorem that in whatever way a flexible and inextensible surface may be deformed, the sum of the principal curvatures at each point will always be the same. The calculations of the elements of the asteroids Pallas, Ceres, Juno, and Vesta, were made by Gauss, and attracted all the more attention because they furnished the first occasions on which all the elements of a planet had to be determined in a short time and by a small number of observations. The methods were not yet even fixed, because no one had taken up the subject. The process adopted by Gauss was simple and confessedly worthy of the attention of astronomers. Gauss has been called the godfather of the planet Vesta, from his having selected the name for it. In two papers on the comets of 1811, he gave a new and much more simple method than had been practiced before to determine the elements of a comet with the smallest number of observations. While actively engaged in the measurement of the degree in Hanover, Gauss devised the instrument known as the heliotrope, which has since come into general use in all geodesic observations.

Gauss engaged also in researches on magnetism, concerning which he published a paper in 1833 on the intensity of terrestrial magnetism. He and Prof. Wilhelm Weber invented new magnetic apparatus, including the declination instrument and the bifilar magnetometer. They erected at Göttingen an observatory, free from iron, where he made magnetic observations, and—anticipating the electro-magnetic telegraph—sent telegraphic signals to a neighboring town.

His collected works, edited by E. J. Schering, have been recently published by the Royal Society of Göttingen in seven volumes. With them are included notices by him of many of the memoirs, and of works of other authors in the "Göttingen gelehrte Anzeigen," and a considerable amount of previously unpublished matter. Gauss was a member of all the important learned societies.

One of Gauss's last acts was, a little while before his death, to have engraved at the foot of his portrait, as giving the best summary of his views and labors, the lines from Shakespeare's "King Lear":

> "Thou, Nature, art my goddess; to thy laws
> My services are bound."

CORRESPONDENCE.

EDUCATION FOR MOTHERS.

Editor Popular Science Monthly:

MR. GEORGE L. GUY, in his address quoted from in one of the "Notes" of the April "Popular Science Monthly," asserts that "our bookish education" does not "in any sense fit our young people to enter upon the practical duties of life."

Why should it not? If a physician be called to attend a very ill child when perhaps the nursing is most important, which will give him the greatest sense of strength—the ignorant mother blindly striving to ease present pain regardless of future consequences, or the woman accustomed to use her reason? The first perhaps can not even read the labels on his bottles, the second can take notes of all he directs and give him on his return a faithful account of what has passed during his absence.

Often a mother's daily wish is that her education had been better, that she might more easily keep pace with her sons, who demand her sympathy in their intellectual pursuits, knowing that she can not share in their rough play. There are many rainy days, times of sickness or *ennui*, when the boys want occupation that can satisfy their growing minds, and yet not savor too strongly of the school-room. If their mother can make history interesting from her own full knowledge, which enables her to select a good book or to embellish a rather dull one, even quite little fellows will turn from childish stories with delight to listen. Another child longs to know something of the great forces about him. Why does an engine go? What is a compass? Endless are the questions, and happy the mother who can keep her sons about her while together they find the answers. If she can draw, again there is a pleasure in the lessons she can give in odd moments, and, almost without a thought on the child's part, he finds he can use a pencil, enjoying it in untold ways. It is the same with music, with the languages, botany, and many other studies. Children can not learn all they need at school, neither can we give them too many extra hours for lessons. Their afternoons and holidays must be as free for pure play as possible; but when, owing to circumstances, that can not be had, do not let them be idle; help them to the habit of employing their minds or hands usefully. How can a mother do that, especially for boys, if she only knows how to sew, to keep a house in order, and attend to the younger children? The baby needs her care for its frail bodily life—do not the minds and souls of her older children also cry out to her? MRS. WILLIAM F. JENKS.

PHILADELPHIA, PA., *March* 27, 1883.

THE UNITY OF TRUTH.*

Editor Popular Science Monthly:

WE still hear from time to time of sad examples of dogmatic utterances of the Church on subjects pertaining wholly to science. The last of these occurred only a few weeks ago at Baltimore. It seems impossible for most people to learn from experience unless the experience be personal. Only the reflective learn wisdom from history.

It is for this reason that we hail with pleasure the work before us. Its liberal spirit is as rare as its Christian fervor is deep. When clergymen have the boldness to write such books, and congregations the liberality of thought to receive such instruction, surely the traditional conflict between theology and science is nearing its end.

The writer assumes throughout the truth of evolution, and strives with great learning and eloquence to show that it does not destroy but only confirms all that is most essential in Christian belief.

We most heartily recommend the book to all truth-seekers, and especially to clergymen of all denominations.

JOSEPH LE CONTE.

BERKELEY, CAL., *June* 12, 1883.

MORE ILLS OF CITY LIFE.

Editor Popular Science Monthly:

THE article by Walter B. Platt, M. D., on "The Injurious Influences of City Life," in the August "Monthly," suggests a mention of the mental and nervous irritation caused by the petty annoyances and trespasses on individual rights constantly being inflicted by the jostling throng of a city. We are elbowed and nearly upset, our toes are trodden upon, and our sides are punched with umbrellas and market-baskets by the crowd in cars and ferry-boats, which are crowded because the corporations that own them take our money without giving us proper accommodations in return. At places of amusement, our view is cut off by persons who stand up or sit with large hats on in front of us. At home, dwellers in flats receive various disagreeable sounds and smells from their too close neighbors. In hardly any place are we secure from being pestered

* "The Unity of Truth." By Rev. Max Hark.

to buy what we do not want, or being tortured with wretched music and then asked to pay for the infliction. These things and many others of like nature produce more or less mental irritation, according to the sensitiveness of the individual, and help to make up the too great load which the nerves of city dwellers have to bear.

Still another injurious influence, more similar to those mentioned by Dr. Platt, comes from the frequent startling by sudden noises, or the sudden appearance of danger in city streets. As Dr. Platt pointed out, the noises of a city are legion. Many of these are so loud and abrupt as to cause a momentary fright; for instance, the crash of wagons and cars in collision, the striking and scraping of the hoofs of horses struggling for a footing on a slippery pavement, the fall of cases, barrels, iron rails, etc., being unloaded from trucks, the blasting for the foundations of buildings (in the outskirts of the city), and other noises, which, while no one may occur often, together make up a large aggregate. In addition to these startling sounds, the city dweller is continually receiving impressions of impending danger through the eye. Among these are the causes of the noises just mentioned, if they are close at hand—the toppling wagons, the plunging horses, and the boxes of goods and pieces of building-material escaping from the hands of workmen. Also may be mentioned recklessly driven vehicles, coming upon a foot-passenger from behind at street-crossings; the sudden appearance close to one's face of a long pole, gas-pipe, or other burden carried on the shoulder of a man along a crowded sidewalk; and many similar things incidental to the compressed activity of a city. The shock to the nerve-centers which these momentary frights give, and the nervous strain which the city dweller endures from keeping a lookout for such dangers, can not fail to impair the strength of the nervous system. Through the nerves an injurious influence is exerted upon the heart also. Sudden fright, or other violent emotion, disturbs the working of the heart, and often so far arrests its action as to produce fainting, while cases of immediate death from this cause have been known. Even when the fright is not serious, the cumulative effect of being startled so often must contribute to the growing frequency with which the city dweller "breaks down but doesn't wear out."

FREDERIK A. FERNALD.

NEW YORK, *July* 18, 1888.

THEORIES OF THE CAUSES OF BALDNESS.

Editor Popular Science Monthly:

FROM time to time I have noticed theories expressed in the "Monthly," setting forth the chief causes of baldness, such as abnormal heat from the head-cover, "constriction of the blood-vessels of the head by tight hats," by Mr. Eaton and Mr. Gouinlock. Prof. T. Wesley Mills holds that "the principal root of the trouble is in nervous strain." All these theories may have something to do with the loss of hair. I am not about to discuss these several theories, or suggest one myself, but will only endeavor to point out a few facts which may be interesting as bearing upon the subject. During several years' residence in Hong-Kong, in my professional duties I had to do with a goodly number of persons, representing a large variety of nationalities, and in my study of these people I found that many theories deduced from local experiences at home were, in some cases at least, hardly broad enough to cover all facts found at large in nature bearing upon the specific points of investigation. Familiar with some of the popular theories as to the cause of baldness, I was surprised to find men who always wore a covering to their heads, and during business hours and always when out of doors wore a very tight hat, were never bald, and possessed a wonderfully strong, thick head of hair. I refer to the Parsees (Persians). There is a sacred, religious law among them that no man shall go with his head uncovered. When the Mohammedans invaded Persia, the major part of the native Persians that were not exterminated fled farther east into India, found protection and a welcome home among the Hindoos, a people of *castes*, and, in order that these strangers should always be identified, also knowing that their religion obliged them to wear a head-cover, a law was passed to compel all Parsees (Persians) * to wear a certain style of hat whenever exposed outside of their own private home. The hat prescribed is as tall as an American silk hat with no brim; it truly might be called a "stove-pipe." This hat is worn, inclining backward on the head from thirty-five to forty degrees, and, in order to keep it on its place, the rim is made to cling very close to the head; being so tight and so constantly worn, quite a deep depression is caused substantially around the head; it seemed as if the skull might be involved, but, not having the opportunity of examining one, I was not able to fully determine. Whenever this hat is removed, a skull-cap immediately takes its place. In my professional duties, these hats often had to be removed, and it appeared to me as a curious fact—if some of the popular theories were altogether true—that these people should never be bald. Therefore, I instituted a series of strict inquiries. Many of these gentlemen spoke English intelligently, also French, German, Persian, and their local Hindoo dialect, some of whom kindly allowed an examination of their heads, and also assured me that they had never known one of their race that was bald.

G. O. ROGERS.

CITY OF MEXICO, *April* 19, 1888.

* The term Parsee (Persian) is used in contradistinction to the invading Mohammedan Persians, who are now habitants of the country.

EDITOR'S TABLE.

THE OPPOSITION TO DARWINISM.

THE "Contemporary Review" for June contains a timely article by Mr. Romanes in reply to recent attacks on Darwin and the Darwinian theory of natural selection. Mr. Romanes first applies himself to answering an anonymous writer in the "Edinburgh Review," who, not content with opposing Darwinism, assails the character of Darwin himself. Here Mr. Romanes has an easy task; for, if anything is obvious to an ordinarily candid mind, it is that the author of the theory of natural selection was a man of a rare elevation and disinterestedness of spirit—a man whom, so far as his personal attributes were concerned, any school of thought might be proud to call its chief. The "Edinburgh Reviewer" tries to prove from the "Life and Letters" that Darwin was a vain man, wedded to his own notions, greedy of flattery, and impatient of criticism. The record is there; he who runs may read, and no one save the reviewer has yet read what he professes to have done.

Mr. Romanes's more serious concern, however, is with the criticisms of the Duke of Argyll; and, to our mind, he deals in a very effectual manner with that writer's contention that natural selection can in no sense be a cause of the formation of species. Natural selection, it is urged, does not produce the variations that occur in Nature—*ergo*, it can not explain the origin of species. To this Mr. Romanes replies that natural selection is precisely the thing which gives vitality and perpetuity to certain variations, and which causes others to perish, and that, in that sense, it is as truly a cause of species as any one thing can be of another. If natural selection is not a cause of species, then neither is the intervention of the breeder a cause of the varieties which we know his art produces among domestic animals; for the breeder does not make the congenital variations upon which he works; he simply chooses among them those which he wishes to preserve and, if possible, establish and develop. If the reaction of the environment exercises a selective influence upon variations spontaneously produced, extinguishing most, favoring a few, we may with perfect propriety speak of that as "natural selection," and may regard it as a cause of species just as we regard any other necessary antecedent or condition of a given phenomenon as a cause of that phenomenon. We need not personify it in doing so, need not make a metaphysical entity of it; all we are called on to do is to attest the fact—if the facts appear to warrant it—that, by a process of natural selection, species are formed.

But Mr. Romanes makes a very true remark when he says that the Duke of Argyll's quarrel is really not with natural selection as a special theory, but with natural selection considered as one aspect of the general doctrine of evolution. What his Grace objects to is that idea of *natural causation* which the doctrine of evolution implies; for there would be absolutely no advantage, from the duke's point of view, in destroying the theory of natural selection if the scientific world were straightway to set about discovering some other natural hypothesis to take its place. What the duke, therefore, has to show is that nothing can be naturally explained, and therefore that all attempts of the nature of Darwin's are predoomed to failure. The moment we admit the efficacy of natural causes at all we start upon a career of explanation to which, in the very nature of things, there are no lim-

its. If, therefore, the Duke of Argyll does not wish us to frame large hypotheses, he must prohibit and prevent our forming small ones. He must break us into seeing miracle everywhere. There is really no tenable middle ground between the reign of superstition, with all its blindness and terrors, and the reign of science, with its calm, undismayed survey of realities. The Duke of Argyll and other assailants of evolution may find many flatterers among the timid and the reactionary, but they will not persuade the world to return to the standpoint of the middle ages, nor will they ever succeed in appreciably retarding the march of science or the growth of a scientific philosophy.

PETITIONS FOR RAIN.

The vicissitudes of the seasons give rise every year to more or less controversy as to the propriety and efficacy of petitions for changes in the weather; and we notice discussions of this character now in progress in different quarters. It is ill arguing against sentiments that have almost the force of instincts; and we have no wish to say or do anything calculated to check the exercise of a religious spirit. The number, however, is probably increasing from year to year of those who are disposed to regard the question referred to mainly as one of evidence, and in the few remarks we have now to make, it is this class exclusively that we have in view.

Among the things we know on this subject is the fact that, in all ages, the weather has been a frequent cause of anxiety to mankind, particularly to those immediately depending on the soil for the reward of their labor. In all ages there have been seasons of hurtful drought and seasons of excessive rain, seasons of deficient heat and seasons of undue heat, and men have been compelled to adapt themselves to these varying conditions as best they could. Occasionally the abnormities of the weather have been such as to produce famine on a wide scale; and it is to be remarked that the intensity of these visitations has been proportioned to the ignorance and general backwardness of the communities upon which they have fallen. In all ages prayer has been resorted to as a means of obtaining propitious seasons, and often it has been re-enforced by sacrifices, human or other; but history furnishes no evidence whatever that the weather has at any period, or under any religious dispensation, been governed or modified by such expedients. What has been the case in the past holds good to-day. We have, like the ancient Romans, Greeks, Indians, and Chinese, our favorable seasons and our unfavorable ones. The farmer has his battles to fight just as of old; and there is, perhaps, reason to believe that his more highly developed, or, at least, specialized strains of fruits, vegetables, and grains are more liable to the attacks of parasites, and more sensitive to atmospheric conditions, than were those of ancient times. On the other hand, the civilized farmer of our century has a greater command of scientific knowledge wherewith to combat his foes than was possessed by the agriculturist of two thousand or even of one hundred years ago, while the community as a whole possesses resources of capital and facilities both of communication and of transportation such as to put famine on a large scale almost out of the question. We may thus claim to have positive and conclusive evidence that the security of human life depends in the most direct manner on knowledge and social organization, while we are compelled to recognize a complete lack of evidence that it depends directly or indirectly on anything else. What is true of the vicissitudes of the seasons is true also of diseases and pestilences. Prayer has always been resorted to to ward them off; but history tells us that, in ages of ignorance, they were vastly more severe and destructive than they

are to-day. We combat them successfully by knowledge: that is evident; and it is not evident, nor, indeed, is there a scintilla of proof, that we combat them successfully by anything else. Of course, if we choose, we may believe without evidence; but whether it is wise to force belief in this manner, or to allow it to be dominated by mere sentiment, each one must decide for himself.

To us it seems the part not of wisdom only, but in a true sense—the truest sense—of piety also, to take the world as we find it; to acknowledge, with Matthew Arnold, that

> "Limits we did not set
> Condition all we do";

and then to apply ourselves with all the courage and energy we can command to making the best of the conditions we find prevailing. The more adverse those conditions, the more scope there is for the active brain and resolute will. The intellectual advancement of the civilized man of our day is a measure of the difficulties he has faced and overcome. The most wholesome view, therefore, to take of an unfavorable season is to regard it as an obstacle thrown by the constitution of nature in the way of human effort, but an obstacle which, by developing patience and stimulating reflection, may itself be productive of good results. It is doubtless hard to be philosophical when severe pecuniary loss is staring one in the face; but it may not be amiss to reflect that what to-day is a matter of not irremediable loss might, in days when faith was more active but knowledge more scanty and co-operation less developed, have meant actual death by starvation. It is something to live in an age and belong to a community in which industrious men do not starve, even in the worst of times. If, therefore, we can not command the weather, let us make the best of such weather as we can get, and strive by forethought, by energy, by co-operation with our fellows, to establish more and more effectual compensations for the inequality of the seasons and whatever other disadvantages may be inseparable from our existence on a globe which probably was not fashioned solely with a view to our comfort.

THE PURPOSE OF MANUAL TRAINING.

Our "Popular Miscellany" last month contained two paragraphs in which were embodied some excellent thoughts on the value and purpose of technical education, or "hand-training," in schools. The analysis of the real object of the instruction given by Prof. Le Conte so clearly indicates the direction which the teaching should take, and the tendencies it should encourage, that it may well be referred to again.

As drawing should be taught, Prof. Le Conte affirms, not for making artists, but for training the brain through eye and hand, so hand-work instruction should be given with a similar aim, rather than for making carpenters and blacksmiths. While in biology the training is mainly of the brain through the senses, in hand-work it is mainly of the brain through the hand. If the former is mainly observing and thinking, the other is mainly thinking and doing. It is impossible to doubt the importance of hand-training from this point of view. The absolute necessity of the use of the hand in the brain-culture of the child, and the importance of the use of instruments of research in the best scientific culture of the university, are now admitted by all. But in the wide space between these extremes of the educational course—viz., in the school and the college—this great agent of culture is wholly left out. Now, it may be assumed as certain that for every grade of culture, whether of the individual or of the race, there is a corresponding grade of hand-work necessary for the best brain-development. In the child of pre-school age, and in the savage, it is the simple use of the hand, or of the hand assisted by rude implements. In

the school boy or girl, as also in the next grade of civilization above the savage, the object is furthered by the use of those finer instruments which we call tools. In the university, as in the most civilized races, it is by the use of scientific instruments and machines. The three grades of hand-work, then, in their adaptation to brain-culture, are the use of rude implements, tools, and finer instruments.

Mr. G. S. Ramsay has shown that the advantages which workmen of certain other countries are supposed to possess over British workmen in the same trades are due not so much to mere special skill in manipulation as to the superior general scientific knowledge possessed by them and those who have the directing of them. The German beet-sugar industry has attained its great proportions by making the technical part of the work subordinate to the scientific principles on which it is based. So American and Canadian butter and cheese have gained the predominant place in British markets through the makers having been wide-awake and having adopted all the scientific improvements in treatment and processes which the home makers neglected. In each of these and other cases cited by Mr. Ramsay we find the same state of things: the producer "fails to understand the importance of pure knowledge; he despises and disbelieves in principles, and imagines that the only thing he need know is what applies to his own particular work."

These views are wholesome, and it promises well for the future of technical education that they are gaining currency among the persons who are endeavoring to make this branch of instruction a living fact in schools.

Lord Armstrong, criticising, in the "Nineteenth Century," the English system of elementary education, charges it with being liable to the radical objection of "aiming at instruction in knowledge rather than in the training of the faculties," and adds that "cheapness of production and superiority of quality will decide the victory in the race of competition, and if by early training we develop the mental and bodily faculties of our people, we shall improve our chance of maintaining a foremost place; but not, I think, by any forced or indiscriminate system of imparting knowledge." This declaration was partly accepted and enlarged upon by Lord Hartington, in an address in behalf of the English National Association for the Promotion of Technical Training.

The same thought has been expressed by Lord Ripon, who gave as a reason for being specially interested in the school of handicraft, of which he is patron, that he hoped it might become a center of artistic education for the workingmen, and that they might derive from it not merely benefit in regard to their particular trades, but also in regard to their intellectual advancement and cultivation. By exciting the interest of workmen in their work, and by finding play for their imagination and other faculties, the institution might do something to solve some of the most difficult of existing social problems.

Such declarations, coming from different quarters and made from so many points of view, tend to strengthen the hope that technical education will be built up on the right grounds, firm and solid ones, and that when it has gained its place it will have come to stay. Removed from the narrow basis of merely imparting special knowledge in particular processes to the broader and comprehensive one of fitting those who apply themselves to it both mentally and bodily for pursuits requiring skill and intelligence, it will be brought into harmony with the controlling principle that education is good in proportion as it tends to develop capacities for useful action rather than to increase acquirements in knowledge, and will be destined to form an inseparable part of such education.

LITERARY NOTICES.

ANNUAL REPORT OF THE BOARD OF REGENTS OF THE SMITHSONIAN INSTITUTION, TO JULY, 1885. Part II. Washington. Pp. 264 + 939.

THE first portion of this volume comprises the report of the United States National Museum, made by the assistant director, Prof. G. Brown Goode, reports of the curators of the several departments, a bibliography of the museum publications, and a list of accessions to the collections. These documents cover only the first half of the year 1885, because the reports of the Institution in future are to cover the fiscal instead of the calendar year. The more considerable part of the volume embodies a monograph, by Thomas Donaldson, on "The George Catlin Indian Gallery in the United States National Museum, with Memoir and Statistics," which is illustrated with one hundred and forty-two plates and several maps and portraits. From Mr. Donaldson's memoir, it appears that George Catlin was born at Wilkesbarre, Pa., July 26, 1796, and died at Jersey City, N. J., December 23, 1872. He studied law at Litchfield, Conn., and while there became noted as an amateur artist. He began practice in Luzerne County, Pa., but the law soon had to give way to art, and he removed to Philadelphia in 1823, where he became very popular as a miniature and portrait painter. Catlin's boyhood was passed on his father's farm in the Ocquago Valley, Broome County, N. Y., and on another near Hop Bottom, Pa. The Indians were then being pushed further west, but the locality was still rife with tales of the red men and the pioneers. George's father had served six years in the Revolutionary War; his grandfather on his mother's side had escaped from the "Wyoming massacre" by swimming the river; and when the Indians captured Forty Fort his grandmother and his mother, then a girl of seven years, were among the prisoners. Thus the recollections of his own family, and the stories told by the Revolutionary soldiers, Indian fighters, hunters, trappers, and explorers, who were frequent guests at his father's house, aroused in young George's mind that interest in the Indians which was to become his ruling passion. "The plows in my father's fields," Catlin afterward wrote, "were daily turning up Indian skulls or Indian bones, and Indian flint arrow-heads, which the laboring-men of his farm, as well as those of the neighborhood, were bringing to me, and with which I was enthusiastically forming a little cabinet or museum. . . . I was in a position to increase rather than to diminish the excitement already raised in my mind relative to the Indians." While practicing his art at Philadelphia, he says, "my mind was continually reaching for some branch or enterprise of the art on which to devote a whole lifetime of enthusiasm, when a delegation of some ten or fifteen noble and dignified-looking Indians from the wilds of the far West suddenly arrived in the city, arrayed and equipped in all of their classic beauty. . . . In the midst of success (as a painter) I again resolved to use my art and so much of the labors of my future life as might be required in rescuing from oblivion the looks and customs of the vanishing races of native man in America." This resolve was carried out in his "Indian Gallery," to which he untiringly devoted himself during forty-two years. From 1829 to 1838 Mr. Catlin lived among the Indians, traders, trappers, and hunters of the West, and in this period created the original "Catlin Gallery." His adventures, as recounted in his "Eight Years among the North American Indians," are most entertaining. The medicine-men in some places aroused an opposition to his painting by asserting that the operation took away part of the life of the sitter. But the good-will of a powerful chief generally turned the tide in his favor, and the portrait-making became an honor. But this introduced a new embarrassment when he proposed to paint some of the women, they not being deemed worthy of such distinction. After much debate this also was permitted. Catlin's "Indian Gallery" was exhibited in this country, England, and France, from 1837 to 1852. During this period Mr. Catlin won the esteem and friendship of explorers, scientists, statesmen, and artists, among whom were Mayne Reid, Joseph Henry, Henry Clay, Benjamin Silliman, von Humboldt, Bunsen, William M. Hunt, Daniel Webster, William H. Seward, John A. Dix, Michael Faraday, and John Murray. Before going to Europe he had attached to his gallery of six hundred paintings a museum of several thousand Indian articles,

and during his stay abroad three parties of Indians, brought over by other persons, were exhibited under his management. His "Notes in Europe," describing his experiences, is singularly interesting, especially the parts telling the impressions of European customs gathered by his Indians. In 1852 Mr. Catlin was overtaken by financial disaster, and his gallery and museum were seized, but were released by Mr. Joseph Harrison, Jr., who shipped them to Philadelphia, where they were stored till 1879. From 1846 to 1874 several unsuccessful attempts were made to persuade Congress to buy the Catlin collection. Finally, in 1879, Mr. Thomas Donaldson solicited of the executors of Mr. Harrison the gift of the collection to the Smithsonian Institution, which was speedily effected. In 1852 Mr. Catlin went to South America, visiting the Indians of the Orinoco and Amazon regions, and crossing the Andes to Lima, whence he sailed northward to Panama, California, British Columbia, the Aleutian Islands, and Kamchatka. Returning southward, he visited Yucatan, and, after a trip to France, continued his explorations in Uruguay, Paraguay, and the country south to the Strait of Magellan, and also made some geological observations in Venezuela. These travels are described in his books, "Life among the Indians," "Last Rambles," and "Lifted and Subsided Rocks of America." He went to Europe in 1853, where he remained, painting his "Cartoon Collection," till 1870, when he returned to the United States, and exhibited the collection till his death. The "Catlin Cartoon Collection" consists of copies of some of the original gallery, with a large number of North and South American Indian portraits and scenes, in all six hundred and three pictures. It is now the property of Mr. Catlin's three daughters. A large part of Mr. Donaldson's monograph consists of a catalogue of the Catlin Gallery, interspersed with biographical material from Catlin's books and other sources, concerning the famous Indians whose portraits are therein preserved, and with copious notes on the landscapes, sporting-scenes, manners and customs depicted in the views. The plates which illustrate the paper are reproductions of the paintings. The catalogue is followed by the "Itinerary of Mr. George Catlin, 1830 to 1871, with Notes." The concluding portion of the volume is a sketch of the Indian policy of the Government from 1776 to 1886, with statistics, and includes a map showing all the Indian reservations in the United States in 1885, and another, on a large scale, of the Indian Territory. It is rare that so readable a volume comes from the Government Printing-Office.

PRINCIPLES OF THE ECONOMIC PHILOSOPHY OF SOCIETY, GOVERNMENT, AND INDUSTRY. By VAN BUREN DENSLOW, LL. D. New York: Cassell & Co. Pp. 782. Price, $3.50.

THE dignity of a science is readily claimed for political economy by those who talk or write about it. Yet the application of scientific principles to the investigation of the subjects embraced under that head, or a suggestion to enforce practically the results of a purely scientific investigation, is scornfully rejected by the whole of one of the great schools of economists. Hence, the author, who writes from the point of view of this school, is capable of saying that "political economy has thus far been conducted in a way that makes it a body of fault-finding and carping, by men innocent of any connection with government and but slightly acquainted with business, as to the effect of that legislation whose responsibilities they have never borne, upon that industry toward which they maintain a parasitic rather than a controlling relation." Among the men thus ungraciously snubbed are such authorities as Adam Smith, Mill, Bastiat, Jevons, Cairnes, Bonamy Price, Fawcett, Thorold Rogers, Sumner, John Bright, Prof. Perry, and others, to whose lucid and convincing expositions of the solid elements of national prosperity the world at large has been glad to give an attentive ear. So, "apprehending that political economy must needs teach the functions of government concerning industry, it next follows that the economist must no longer be a member of a mere sect of anti-government critics. Political economy can not attain its true dignity as a scientific expositor of the relations of government to industry so long as the statesmen of the world monopolize the ability to see things as they are, and to do things in a way that is practicable, while the economists indulge in the mere imaginative occupation of theorizing in the

subjunctive mood as to how they might, could, would, or should do. It is time that the economists of every country had ceased to be a sect antagonizing the statesmen; especially is it time that the economists of America, France, and Germany had ceased, in antagonizing the statesmen of their own country, to fall into a species of disloyal alliance with the statesmen of countries whose economic interests may not be in harmony, in certain important and vital aspects, with their own"—the familiar cry of the practical politicians against the "literary fellers." In spite of this one-sidedness, there is a great deal that is valuable in the book, in the fullness of the historical presentations of the various questions, the ample citations of facts, the author's own lucid comments where his bias does not overrule him, and the notes giving views of nearly all economists, all going to justify his belief that it may prove "convenient as a book of reference to the very large number of persons who, if amply supplied with facts, find it not difficult to arrive at their own conclusions." One feature that we can commend in the highest degree is the excellence and fullness of the table of contents and the two indexes. Among the subjects specifically treated are "Wealth," "Value and Prices," "Title and Use," "Profit and Loss," "Capital," "Land," "Labor," "Money," "Crises," "The State" as a factor in various ways, and the different aspects of taxation, protection, and free trade.

PHYSICAL DEVELOPMENT; OR, THE LAWS GOVERNING THE HUMAN SYSTEM. By NATHAN ALLEN, M. D. Boston: Lee & Shepard. New York: Charles T. Dillingham. Pp. 348.

DR. ALLEN has been known for twenty-five years as a writer on the various subjects that fall under the heading of the title of this book. While some of the papers have appeared in special journals and the transactions of societies, many of them have been published in channels through which they went at once to general readers. In all his work he has sought to improve the standard of American manhood and womanhood. Two of the papers in this volume—"Changes in New England Population" and "The Law of Human Increase"—appeared first in "The Popular Science Monthly"; and the former paper, with the one on "The New England Family," attracted very general attention, and were extensively copied and commented upon. They exposed a sore spot in the domestic economy of Americans, and pointed out an evil concerning which there was more sorrowing in silence than brave remarking. There is no doubt that their influence was wholesome, and that in publishing them Dr. Allen did a service to his country. The other papers—there are twenty-four in all—if of less pronounced importance, are valuable as teaching truths bearing upon the health and longevity of the race, and presenting them in such a literary form as to commend them to general reading. We observe that they have been edited in such a manner as to constitute the volume, instead of a mere collection of scattered essays, a compact and harmonious book. The papers are preceded by a biographical sketch of the author, which is accompanied with an excellent steel-engraved portrait.

SYSTEM OF ECONOMICAL CONTRADICTIONS; OR, THE PHILOSOPHY OF MISERY. By P. J. PROUDHON. Vol. I. Boston: Benjamin R. Tucker. Pp. 469. Price, $3.50.

MR. TUCKER is engaged in publishing, by subscription, the complete works of the French socialistic philosopher, in fifty volumes, of which this is in order the fourth, although the second and third volumes have not yet been published in English. As implied in the title, the book is in reality a budget of contradictions, beginning with the question of the existence of God, in respect to which positive and negative statements are hypothecated. Social economy is distinguished by an opposition between fact and right; the science is real, but it is "an immense plain, strewn with materials prepared for an edifice. The laborers await the signal, full of ardor and burning to commence the work; but the architect has disappeared without leaving the plan." The principle of value is discussed in the light of the opposition of value in use and value in exchange. Division of labor is studied as the economic fact which influences most perceptibly profits and wages. The machine and the workshop having given the laborer a master and reduced him from the rank of artisan to that of common workman, the problem is in place

how to cause them, instead of serving exclusively the interests of the least numerous, the least industrious, and the wealthiest class, to be employed for the benefit of all. Against these evils, Providence has sent us competition, whose opposite is monopoly, another evil; and socialism, while it has not succeeded in regulating competition and keeping it from becoming anarchical, is powerless against monopoly, so that we see all reforms ending "now in hierarchical corporation, now in state monopoly, or the tyranny of communism." These contradictions and evils constitute a "long succession of torments" through which it was necessary that society should pass in order that the victory of intelligent and free labor might produce all its consequences. Still other necessities must be met, to disappear, until "the supreme necessity, the triumphal fact, which must establish the kingdom of labor forever," shall come at last.

THE AMERICAN ANTHROPOLOGIST. Quarterly. Washington: Thomas Hampson. Price, $3 a year.

WITH January, 1888, the Anthropological Society of Washington began the publication of this magazine as a continuation of the "Transactions" heretofore published, and for the additional purpose of affording a medium for recording the work of investigators in anthropology who are not members of the society. The first number contains four papers: "The Law of Malthus," by Dr. James C. Welling; "The Development of Time-keeping in Greece and Rome," by F. A. Seely; "Anthropological Notes on the Human Hand," by Frank Baker, M. D.; and "The Chane-abal Tribe and Dialect of Chiapas," by Daniel G. Brinton, M. D. Dr. Baker's paper is of a popular character, dealing with beliefs in the curative or magical virtue of the "dead hand," with palmistry, with expression in the hand, etc. The second number contains the annual address of the retiring president of the society, Major J. W. Powell, delivered March 16, 1886. This is followed by a review of Dr. Rink's "Eskimo Tribes," a paper on "Discontinuities in Nature's Methods," by Henry H. Bates, and "The Prayer of a Navajo Shaman," by Dr. Washington Matthews, with miscellaneous notes and news.

A Hand-Book of the Lick Observatory has been written by the director, Prof. *Edward S. Holden* (The Bancroft Company). The book contains a sketch of the life of James Lick, descriptions of Mount Hamilton, and the buildings and instruments of the Lick Observatory, information for intending visitors, a poem "To the Unmounted Lens," by A. V. G., together with chapters on the work of an observatory, telescopes, astronomical photography, clocks and time-keeping, and the principal observatories of the world. The text is illustrated with woodcuts.

A little book of *Chemical Problems* has been prepared by Dr. *J. P. Grabfield* and Mr. *P. S. Burns*, of the Massachusetts Institute of Technology (Heath). The problems are classified according to the chemical principles on which their solutions depend. These principles are stated briefly at the head of each section, and the method of solving the problems is illustrated. The latter half of the volume is made up of examination papers, which consist partly of problems and partly of questions.

The three introductory lectures on *The Science of Thought*, by Prof. *F. Max Müller*, and the correspondence on "Thought without Words," all of which has been published in "The Open Court," are now issued in book-form (The Open Court Publishing Company, 75 cents). The three lectures deal with "The Simplicity of Language," "The Identity of Language and Thought," and "The Simplicity of Thought." In the second of these the author sets forth his doctrine that it is impossible to think without words, which provoked the correspondence that is appended. The writers of these letters are Prof. Müller, Mr. F. Galton, the Duke of Argyll, Mr. George J. Romanes, and others.

It will be pardonable to give a little space to *Law of Heat*, by Mrs. *Maria R. Hemiup* (The author, Geneva, N. Y., 75 cents), with the view of dissuading others from wasting time and money as she has done in promulgating impossible theories in science. Twenty years ago Mrs. Hemiup hit upon a theory to account for the bursting of containing vessels by freezing water, differing from the one commonly accepted. The present volume consists of her original newspaper article stating the theory, with some

correspondence about it, several quotations from eminent physicists, which she imagines support her theory, and a lot of irrelevant matter. Her screed is a "terrible example" of the way untrained persons form conclusions about scientific matters in absolute defiance of the scientific method of investigation. She says, "I assume that heat always causes bodies to expand, and that cold always causes bodies to contract, but never expand." Again, "I claim that cold water is always more dense than that of a more elevated temperature, and can not rise upon the surface of that which is warmer." Not a measurement nor a test of any sort does she bring forward in support of these assumptions, and, of course, can not, for her statements are flat contradictions of readily demonstrable facts. Further, she says, "As electricity is diffused throughout all space, it pervades water to a certain extent, and it always remains in a latent state except it is excited to action by some disturbing influence. And, again, as cold increases in temperature the water increases its density, and when it reaches the freezing-point it condenses to that extent that the pressure and friction excites the electricity to heat and converts little particles of ice into steam, which moves with great velocity and power; as the steam rushes out the cold air rushes into the little voids and takes the place of the steam, which causes the report called cracking of the ice. . . . It is first little particles upon the surface that are condensed into ice, and they would instantly sink if they were not arrested in their course and rendered light by the above-mentioned process." Has Mrs. Hemiup ever observed any one of these phenomena? Has she ever detected an electric current in a dish of freezing water with the galvanometer? Has she ever collected any of the little puffs of steam as it escaped from the forming ice? Has she ever seen, either with the naked eye or the microscope, the first-formed little particles of ice floating free on the surface of the water? Other people have seen the first ice-particles attached to the sides of the containing vessel or the shore; hence it can not be true that "they would instantly sink if they were not arrested in their course" by the action she describes. The letters about her theory which she has extracted from prominent scientific men are no indorsement of it, but are either politely non-committal or frankly opposed to her view. She gives the reader no reason to believe that she has ever performed a single experiment to test her supposition, or that in the twenty years or more during which she has speculated on scientific subjects, she has found out what valid evidence is, or what makes a hypothesis tenable. The effect of such a publication is harmful if it falls into the hands of persons whose common sense is not of the robust type, for it is sure to increase any tendency to foggy thinking which the reader may have.

The second annual report of the *Photographic Study of Stellar Spectra*, conducted at the Harvard College Observatory, and constituting the Henry Draper Memorial, relates that the additional facilities provided by Mrs. Draper have permitted a considerable extension of this research during the past year. The 11-inch refractor belonging to Dr. Draper, and an 8-inch photographic telescope, have been kept at work throughout every clear night. The 28-inch and 15-inch reflectors constructed by Dr. Draper have been moved to Cambridge, and the first of these instruments will probably soon be employed regularly. Four assistants take part in making the photographs, and five ladies have been employed in the measurements and reductions. The catalogues of spectra of bright and of faint stars, and the detailed study of the spectra of the brighter stars, will be finished, except for about one quarter part of the sky, which is too far south to be conveniently observed at Cambridge, in about a year, and it is proposed to then send an expedition to the southern hemisphere to complete the work to the south pole. The 28-inch reflector will be used for observing faint stellar spectra.

Bulletin No. 3 of the New York State Museum is an account of the *Building-Stone in the State of New York*, by *John C. Smock* (Albany, State Museum). All the large quarries were visited, to obtain material for this paper, and information was obtained also from quarry-owners and managers. The Bulletin comprises an account of the geological position and geographical distribution of building-stone in New York, and descriptive notes of quarry districts and quarries.

These notes give the location of each quarry, the character and position of the rock, manner of working, uses of the product, etc. The results of tests to determine the structure, hardness, and comparative value of these stones are deferred to another Bulletin.

Studies from the Biological Laboratory of Johns Hopkins University, Vol. III, No. 3, contains papers, based on experiments, with plates for illustration, "On the Laws of Muscular Stimulation and Contraction," by George T. Kemp; and "On Tetanus and the Velocity of the Contraction Wave in Striated Muscle," by John P. Cambell.

In a letter to the Prince of Boncompagni on *Various Points in the History of Mathematics*, which is published at Rome and Paris in French, M. Charles Henry discusses the problem of inscribing a triangle within a circle, as proposed in Ménon; the origins of the planetary signs and the Arabic numerals, and a number of other problems that have engaged the attention of students at various times.

The eight lectures on *The Social Influence of Christianity*, delivered by *David J. Hill*, LL. D. (Silver, $1.25), before the Newton (Mass.) Theological Institution in 1887, have been issued in book-form. The purpose of these lectures is to show how much and in what way Christianity has improved the character of our civilization. In the first lecture the nature of human society is discussed; the second is a summary reply to the question "What has Christianity done for Society?"; and the other lectures deal respectively with the relations of Christianity to the problems of labor, wealth, marriage, education, legislation, and repression. Doubtless some readers would be inclined to ascribe to other causes a part of the effects which the author credits to Christianity. In connection with the pictures which he gives of past progress, the author frequently expresses his opinions, or presents arguments, on sociological questions which are to be decided in the future. The book is methodical in arrangement, scholarly in tone, and readable in style.

The Realities of Heaven, eight lectures by the Rev. *T. F. Wright* (W. H. Alden, Philadelphia, 40 cents), is an exposition of the doctrine of resurrection and immortality, from the point of view of the Swedenborgian or New Church.

Opposite in point of view from the two preceding volumes is *The Bible of Nature*, by *Feliz L. Oswald* (Truth-Seeker Company, $1). This is a spirited effort to state the principles of a religion of Nature, pointing out incidentally many ignorant, cruel, and revolting practices that have gone on under the authority of Christian churches. "The religion of the future," says Dr. Oswald, "will preach the gospel of redemption by reason, by science, and by conformity to the laws of our health-protecting instincts." Its principles as here set forth are comprised under "Physical Maxims," viz., health, strength, chastity, temperance, and skill; "Mental Maxims," viz., knowledge, independence, prudence, perseverance, and free-thought; "Moral Maxims," viz., justice, truth, humanity, friendship, and education; and "Objective Maxims," viz, forest-culture, recreation, domestic reform, legislative reform, and the priesthood of secularism. The author sets forth the promptings of our normal instincts in regard to each of these matters, states the penalties of neglecting such promptings, and the rewards of conformity to them, with suggestions for reforming the present condition of society.

The author of "A Modern Zoroastrian," Mr. *Samuel Laing*, has issued a pamphlet entitled *Agnosticism and Christianity* (Watts & Co., London), in which he debates the question whether the two subjects of his essay are reconcilable. With that form of Christianity which disregards theological theories, and consists in imitation of the character of Jesus of Nazareth, he says agnosticism may well join hands, but that many of the harsh and incredible doctrines of the Old Testament and the churches may be, and are becoming, neglected by both Christians and agnostics. He does not believe that the loss of faith in a system of rewards and punishments in a future life would be a death-blow to morality, for the reason that, by the evolution of the human race, morality has become instinctive in civilized communities. He states briefly the "philosophy of polarity," which he has found most satisfactory, and closes by saying that the duty of a man of the nineteenth century being to follow truth at all hazards, he will find himself

constrained to adopt the scientific theory of the universe. But he must show "that the larger creed leads to a larger life; that it makes him more liberal and tolerant, more pure and upright, more loving and unselfish, more strenuous, as becomes a soldier fighting in the foremost ranks in the campaign against sin and misery; so that, when the last day comes, which comes to all, it may be recorded of him that his individual atom of existence left the world, on the whole, a little better, rather than a little worse, than he found it."

The latest attempt to design an ideal republic is contained in *Looking Backward*, by *Edward Bellamy* (Ticknor, 50 cents), which has the form of a story about a Boston young man who went into a trance for over a century, to recover consciousness among the family of a retired physician with a charming daughter. Stripped of its narrative dressing, the author's plan for reorganizing society is, that the people manage the whole industry of the country through the government. Each individual contributes to the common labor all he can of the kind of work he is best fitted for, and each draws from the public storehouses an equal share of goods. The saving of misdirected effort under this system makes it possible for all to be mustered out of industrial service at the age of forty-five, having entered it at twenty-one, after a liberal education. Houses and land are rented from the government. Money has no function. Accumulations of personal property become burdensome the moment they exceed what adds to the real comfort. The dread of want and desire of luxury being eliminated, the motives relied on to draw out the best efforts of the citizens are honor, patriotism, and the sense of duty. For the first three years after persons reach the industrial age they are assignable to any occupation, which makes all work of equal honor, and gives a prodigious impulse to the invention of labor-saving devices. The classes deficient in body or mind are regarded as members of the same family as their stronger brethren, and receive support and care as a right, not as charity. Hours of labor are less in the more disagreeable and laborious occupations, so as to make all equally attractive. Women are organized as an allied force in the industrial army, and employed for a few years in occupations suited to their sex. They have a world of their own, instead of entering into an unnatural rivalry with men. Marriages are contracted only from inclination or sexual selection. Most of the evils of all sorts which we at present deplore are eliminated by removing the conditions which put a premium on baseness.

The alcohol question is treated in a liberal but earnest manner by *G. H. Stockham*, M. D., in his little book entitled *Temperance and Prohibition* (The author, Oakland, Cal., 75 cents). Dr. Stockham gives a sketch of the temperance movement, accounts of the making and adulteration of alcoholic beverages, and a statement of the observed physiological action of alcohol. He includes also a summary of the liquor laws of Great Britain and America, with a chapter on prohibition, and one on suggested remedies for intemperance. He condemns prohibition as being ineffectual and tyrannical, and condemns also the licensing of saloons, as encouraging drunkenness and crime. He thinks a great step in the right direction would be to grant licenses only for the sale of beer, cider, and light wines to be drunk on the premises, and for the sale of spirits not to be drunk on the premises. He would be glad to see closer restrictive measures than these when society has been educated up to the point of supporting them.

Modern Speculation is an address by *M. W. Quick*, of Titusville, Pa., before the New York State Grange, January 24, 1888. The address points out the evil effect of gambling in agricultural produce on the prices of such articles, and asks the support of farmers in securing legislation to prevent fictitious sales of agricultural commodities. The pamphlet contains also the text of a bill having this object, with answers to objections, and explanations of the terms used on the exchanges.

A number of documents important for students of American and English history are made readily accessible in the *Old South Leaflets* (Heath, 5 cents a copy; one hundred copies, $3). They are pamphlets of twelve to twenty pages, without covers, and the General Series at present comprises the follow-

ing thirteen numbers: 1. Constitution of the United States; 2. Articles of Confederation; 3. Declaration of Independence; 4. Washington's Farewell Address; 5. Magna Charta; 6. Vane's "Healing Question"; 7. Charter of Massachusetts Bay, 1629; 8. Fundamental Orders of Connecticut, 1638; 9. Franklin's Plan of Union, 1754; 10. Washington's Inaugurals; 11. Lincoln's Inaugurals and Emancipation Proclamation; 12. "The Federalist," Nos. 1 and 2; 13. The Ordinance of 1787.

A gossipy little book is *From Lands of Exile*, by *Pierre Loti* (Gottsberger, 90 cents), consisting of letters written by a French naval officer from Annam and neighboring stations, with a story about "An Old Salt" and his daughter.

A rival of Volapük for the office of the universal language is presented by *Alexander Melville Bell*, in his pamphlet entitled *World-English* (N. D. C. Hodges, New York, 25 cents). World-English is the English language unburdened of its chaotic spelling, and with this change Prof. Bell deems it better suited than any other language for international use, on account of its grammatical simplicity and its already wide diffusion. Another use for this simplified form of the language which he urges is in teaching children and foreigners to read the present form, or "literary English," which he does not seek to displace. Prof. Bell recognizes the same sixteen vowel-sounds as the American Philological Association does in its scheme for the phonetic writing of English, for, although he omits two of them from his list, he distinguishes them in his exemplifications. He clings to the peculiar English uses of the vowel-letters, which makes the step from a foreign language to World-English harder, and that from the latter to "literary English" easier, but he distinguishes the unrepresented vowels by the aid of diacritics, in agreement with the usage of other languages. He thus avoids new letters in representing the simple vowels, but introduces one for the diphthong known as "long *i*," while "long *u*" (as in *mute*) he resolves into *yu*. He proposes no less than nine new letters for unrepresented consonants, three of these being the initial sounds in *when* and *hue*, and the sound of *r* when not before a vowel—refinements of notation which the Association does not deem necessary. In the case of the "obscure" sounds of unaccented vowels, however, he agrees with the Association in not deeming a special marking necessary. If we must have new letters for six or nine consonants, by all means let us take Prof. Bell's, for they are the simplest and neatest yet devised. Six of them are simply *c*, *s*, *z*, *t*, *d*, and *u*, with the tail of *p* added; the others are slight modifications of *w*, *n*, and *r*. He retains *k* rather than *c* for the final consonant in *pack*. He makes an odd slip in one place, in giving *nation* and *vicious* as words containing the sound of *ch* in *church*; he also marks the *u* in *January* like that in *February*. He says that "the terminations in *certain*, *fountain*, *foreign*, *cottage*, *courage*, *language*, etc., are regularly contracted to *-in*, *-ij*, and are so written in World-English," but we believe most persons pronounce these syllables more like *-en* and *-ej*. Prof. Bell uses no capitals in World-English, and marks the accent, when this is not on the first syllable, by a vertical line after the vowel of the accented syllable. In the case of a diphthong, he puts the mark between the two letters, which is somewhat confusing. The above objections refer only to details, and the scheme as a whole is much preferable to the mixture of Roman letters and "visible speech" symbols which Prof. Bell proposed in "Science" in 1883. The appearance of World-English, Volapük, and the various other plans for simplifying our mediums of communication, are signs that language is coming to be regarded as a tool that may be improved without disrespect to our grandfathers.

In an essay on *Science in Secondary Schools*, which received a prize of fifty dollars, recently offered by "The Academy," *Charles R. Dryer*, M. D., says that the best branch of science with which to break up the memorizing habit acquired by the pupil in the primary school, and introduce him to observation and induction, is physical geography. After this should come physics and chemistry combined, then biology, and last geology. In biology and geology, he advises proceeding from the known to the unknown, to study first what is nearest, rather than what is structurally the simplest. The spirit which he would have dominate science teach-

ing may be gathered from a couple of his maxims: "Never teach with books what can be perceived in objects," and "Never require belief where seeing and understanding are possible."

Judge's Young Folks is the title of a new sixteen-page monthly periodical for children and youth, published by the *Judge* Publishing Company, at $1.50 a year. It contains entertaining stories and sketches by popular authors, colored and wood engravings, "What Little Folks are Wearing," correspondence, and puzzle departments.

PUBLICATIONS RECEIVED.

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Archivos do Museu Nacional do Rio Janeiro. Vol. VII. Ladislav Netto, Director. Rio de Janeiro. Pp. 236, with 27 Plates.

Bancroft, Hubert Howe. California Inter Pocula. San Francisco: The History Company. Pp. 828. $5.

Blair, Andrew Alexander. The Chemical Analysis of Iron. Philadelphia: J. B. Lippincott Company. Pp. 292. $4.

Bonham, John M. Industrial Liberty. New York: G. P. Putnam's Sons. Pp. 414. $1.75.

California, The, Florist's Monthly. Vol. I, No. 2. Florist Publishing Company. Santa Barbara and San Francisco. Pp. 16. 10 cents, $1 a year.

Chamberlin, Edwin M. Eight Hours the Margin of Profits. Boston: Frank K. Foster. Pp. 9.

Columbia College School of Mines. Summer Schools in Chemistry and Photography. Circulars of Information. Pp. 3 and 7.

Drayton, H. S., M. D. The Servant Question. New York: Fowler & Wells Company. Pp. 23. 10 cents.

Hague, Arnold, U. S. Geological Survey. Geological History of the Yellowstone Park. Pp. 21.

Hering, Rudolph. Notes on the Pollution of Streams. Concord, N. H.: American Public Health Association. Pp. 8.

Hawkins, F. B. Mount Vernon, N. Y.: The Growing Youth. June, 1888. Pp. 8. 10 cents, $1 a year.

Hopkins, H. R., M. D., Buffalo, N. Y. The Relations of Mind and Body. Pp. 7.

James, Joseph F., Oxford, Ohio. Index to the Journal of the Cincinnati Society of Natural History. Vols. I–X. Pp. 33.

Johonnot, James. Stories of Other Lands. New York: D. Appleton & Co. Pp. 232. 47 cents.

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Leffmann, Henry, M. D., and Beam, William. Effects of Food Preservatives on the Action of Diastase, Pancreatic Extract, and Pepsin. Pp. 9.

Levis, R. J., M. D., Philadelphia. The Traditional Errors of Surgery. Pp. 15.

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McGill University, Montreal. Annual Calendar. Faculty of Medicine. 1888–'89. Pp. 95.

Martin, H. Newell, and Brooks, W. K. Studies from the Biological Laboratory of Johns Hopkins University. Vol. IV, No. 4. June, 1888. Baltimore: N. Murray. Pp. 72, with Plates. $1, $5 per volume.

Lowell, James Russell. The Independent in Politics. New York: G. P. Putnam's Sons. Pp. 27. 25 cents.

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Meyer, Isaac, translator. On Dreams, by Saint Synesios. Philadelphia. Pp. 36.

Michigan, Agricultural College of, Experiment-Station. The Jack Pine Plains. Pp. 8.

Ohio, Agricultural Experiment-Station, Columbus. Experiments in preventing Curculio Injury to Cherries; and Midsummer Remedies for the Chinch-Bug. Pp. 20.

Photography, Science of. Vol. I, Nos. 1, 2, and 3. Philadelphia: James W. Queen & Co. Pp. 24 each. 10 cents each.

Pratt Institute, Brooklyn, N. Y. Prospectus and Announcement for 1888–'89.

Remsen, Ira, Baltimore. American Chemical Journal. July, 1888. Pp. 84.

Shufeldt, R. W., M. D. The Sternum in the Solitary Sandpiper, etc. Pp. 3. Osteology of Porzana Carolinia (the Carolina Rail). Pp. 16.

Simmons, J. Edward, New York. The Higher Education a Public Duty. Pp 32.

Signal Service, U. S. Annual Report of the Chief Signal-Officer for 1887. Part I. Washington: Government Printing-Office. Pp. 861.

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Taussig, F. W. The Tariff History of the United States. New York: G. P. Putnam's Sons. Pp. 269. $1.25.

Thomson Electric Welding Company. Electric Welding of Metals. Pp 16.

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Vaughan, Victor C., and Novy, Frederick G. Ptomaines and Leucomaines. Philadelphia: Lea Brothers & Co. Pp. 316. $1.75.

Vuillemin, Paul. La Biologie Végétale (Vegetable Biology). Paris: J. B. Baillière & fils. Pp. 380.

Ward, Lester F. What shall the Public Schools Teach? Pp. 10.

Ward, Thomas Humphry. International Copyright in Works of Art. Pp. 31.

POPULAR MISCELLANY.

The Peabody Museum of American Archæology.—The Peabody Museum of American Archæology and Ethnology received, during 1887, more than 6,600 additional specimens, making 3,267 entries. The largest sent was a collection of 5,261 specimens, made in Lewis and Mercer Counties, Ky., and Adams County, Ohio. A small collection from Fort Berthold, Dakota, includes what is probably the best specimen of authentic—that is, free from the influence of the white man—Sioux pottery that can be obtained; and a wand, illustrating the use to which the singular perforated stones, known

as "gorgets" and "banner-stones," were applied. By the aid of a committee of ladies of Boston, the famous "Serpent Mound" in Adams County, Ohio, has been bought, with about sixty acres of land, put in order, inclosed, and made the central object of an attractive park. "The example," says Curator Putnam, in his report, "thus set for the preservation of the ancient works of this country, has already aroused others to action, and many individuals and societies, particularly in Ohio, are now urging immediate action to prevent the further destruction of our archæologic monuments in the States."

Origin of Lake Superior Iron-Ore.—R. D. Irving, studying the ferruginous schists and iron-ores of the Lake Superior region, has found both of the theories that have been put forward to account for them—that of an eruptive, and that of a sedimentary origin—inadequate. He proposes a new theory, that the rocks have been derived from original carbonates by a metastomic process, or by replacement of the original dolomitic or calcitic rock by siliceous and ferruginous substances. The various steps by which this process took place may have been as follow: 1. The original form of the beds was that of a series of thinly-bedded carbonates, interstratified with carbonaceous shaly layers, which were also often impregnated by the same carbonate. This carbonate was generally more or less highly ferriferous, though probably there were intermediate forms between it and dolomite. 2. By a process of silicification—which varied in degree—these carbonate-bearing layers were transferred into the various kinds of ferruginous rocks now met with in the region. 3. The iron thus removed from the rock at the time of silicification passed into solution in the percolating waters, to be redeposited in various places as it became further oxidized, thus making ore bodies and various impregnations. 4. In other places, instead of leaching it out more or less completely, the silicifying waters seem to have decomposed the iron carbonate in place, producing a magnesia silicate, or a magnesia-iron silicate, the excess of iron oxidizing imperfectly, and separating out as magnetite, and the excess of silica crystallizing finally as a minutely interlocked quartz ground mass. 5. The bodies of rich ore have probably had different origins in different cases. 6. Some of the silicifying process went on before the folding of the formations; but some also afterward. It is not supposed that this theory will not require modification in the future, but it is the one to which the author has been led, without being influenced by any preconceived notions, very gradually, during the growth of his experience with the minerals of the region.

How long one can remain under Water.—The length of the time during which a person can remain under water without choking—a subject on which exaggerated stories have been told—has been studied by M. Lacassagne. The author was favored with an opportunity to examine Captain James, a celebrated diver, whose exploits have excelled those of all his rivals. He pretended to be able to continue four minutes and fourteen seconds under water. He contended once in England for a prize which was offered to any person who could endure five minutes, but was compelled by a hæmorrhage of the nose and ears to rise at the end of four minutes. He had also swum under water during the same time a distance of one hundred and fifty metres. He was accustomed before plunging to expel all the air from his lungs and take a strong inspiration. In the water he swallowed on the average about a litre of the liquid. When he came out of the water he snorted enormously. In one of the experiments to which M. Lacassagne subjected him, the movements of the heart became slow, irregular, and feeble at the end of two minutes; and on his coming out at the end of two minutes and thirty-seven seconds, his face was congested and his eyes flushed. Important facts in the experiments were that in his full inspirations previous to plunging Mr. James swallowed air, and while under the water a considerable quantity of saliva; and that his respiratory movements did not cease during immersion, but continued ample and regular at the rate of twenty a minute, while the thoraco-abdominal cavity diminished at a gradual and regular rate. M. Lacassagne explains these circumstances by supposing that inspiration under water draws into the lung the air contained in the pharynx, which

in turn draws from the air which has been swallowed into the stomach. This organ becomes, then, in the diver, a reservoir of air. It is evident from these observations that if persons who have been trained to diving can not remain under water more than four minutes without exposing themselves to great dangers, drowning men who struggle and inspire water can endure so long only under extremely favorable circumstances. The lesson is also taught that divers should not inflate their lungs before plunging, but should swallow air, which then passing from the stomach to the lungs will support respiration during a definite period of immersion.

Exhaustion from Rowing-Contests.—Prof. W. P. Trowbridge has discussed, in a paper read before the New York Academy of Sciences, the question "whether the excessive training for long-distance boat-races and the violent and long-continued muscular and nervous exertions incident to these contests do not in reality result in unnecessary and hurtful exhaustion during a race, and frequently in permanent injury to the contestants." Prof. Trowbridge says: "The boat-race involves the action of all the muscles, those of the legs, arms, and shoulders, as well as of the back; and hence the demands on the heart and lungs are the greatest possible. The work which a rower performs in each minute of a four-mile race is easily calculated. The distance—21,120 feet—is traversed in about twenty-one minutes. The speed is therefore practically about 1,000 feet per minute. At this speed the resistance to the boat in the water is about 75 pounds. This resistance has been determined experimentally as well as theoretically in England, the average result being 75 pounds. The work per minute for eight men is therefore 75,000 foot-pounds, or 9,375 foot-pounds (4 2 foot-tons) for each man per minute. At the rate of 350 foot-tons in ten hours, the day-laborer performs work at the rate of only six tenths of a foot-ton per minute. The rower in the boat-race, therefore, performs work each minute equivalent to the work of seven strong laborers, or at the rate of nearly one third of a theoretical horse-power each minute during the race. The question now recurs: For how long should these extraordinary efforts be sustained? Four miles in distance and twenty-one minutes in time mark extreme limits of endurance according to all experience in boat-racing; and if races are practically decided at the end of the third mile, or whether they are so decided or not, the fourth mile is a test not of skill and muscular strength, but of the hearts and lungs of the crews. This is rather serious business. Is it quite rational to make the ultimate endurance of these vital organs in a dozen young men a matter of sport and amusement? It is hardly to be expected that any boat-crew will initiate a movement to reduce the length of course from four miles to three; to use an appropriate expression, they 'would die first.' Such a movement might be looked upon as a confession of weakness; but when the suggestion comes from an outsider it is made to all alike, and may at least be discussed with possible profit."

Sanitation among the Negroes.—At a Public Health Conference held in Louisville, Ky., Bishop C. C. Penick read a paper in which he says: "It was startling to the North and the South alike, when the census of 1880 showed the tremendous increase among the colored people, and the cry of alarm ran through the land lest in the near future the black should be the dominant race in this country. The world did not recognize the fact that the great source of Southern wealth had consisted in making the negro prolific. Everything that could be done was done to eradicate all the diseases threatening to interfere with this object. In short, a man's negroes were a man's money, and you may just rest assured that he looked after them." When the race was released from bondage, its momentum carried it up to those startling figures of the 1880 census—figures which Dr. Penick thinks we shall never see again, for there is no longer an intelligent class which has a direct pecuniary interest in the health of the negroes; the latter are leaving the plantations for the less healthful surroundings of the towns, and the enfeebling vices of the town are spreading into the country. In a pamphlet by Dr. G. B. Thornton, of Memphis, it is stated that, although the white population of that city slightly exceeds the black, yet in 1880 a fifth more blacks than whites died, in 1881 a fourth

more, and in the first nine months of 1882 a half more. In the back streets and alleys of Southern cities, where the colored people live crowded together, Bishop Penick says that one may see "squalor, degradation, dirt; green scum in the gutters, dammed with decomposing vegetables, and, it may be, interspersed with a stray cat or dog that came to his untimely end at some uncertain period of the distant past. It does not take a man who knows how to read a diploma in Latin to see that here are conditions most favorable for engendering diseases." During four years spent in Africa he observed that "in his native state and scanty clothing the African is the most cleanly person I ever met. As a rule, he bathes twice a day and oftener in warm water. Deformity among them is as rare as among the birds and squirrels here"; but, on the other hand, that "no sooner did I begin to put clothes on these people than their aversion to water as an external application began to manifest itself, and punishment had to be resorted to to compel those who used to be scrupulously clean to keep moderately decent." Besides the charitable motive for improving the sanitary condition of the negroes, there is another side to the matter. "In other words," says the bishop, "it is a matter of deep concern to every thoughtful man, even if he looks no higher than self-preservation, what kind of diseases cling to those who cook our food, nurse our children, make our beds, wash our clothes, and porter our sleeping-cars. We know that in all of these departments the colored race play a prominent part." The diseases arising from the filth of the back streets and alleys may thus be brought through the back door into homes whose sanitary condition gives their inmates a sense of security.

The Salt-Beds of South America.—The salt-beds on the west coast of South America, according to the description of Dr. Carl Ochsenius, occur in a narrow strip along the coast-line of the rainless district, rarely exceeding twenty-five miles in width. The district is bounded on the east by the Andes, and extends into the coast Cordilleras on the south. The author considers that, before the upheaval of the Andes, salt began to deposit in certain bays, which had been wholly or partially shut off from the sea by the gradual formation of an intercepting bar. Then, while the process of evaporation was still incomplete, the district was raised by volcanic action, and the mother-liquors from the salt-lakes eventually escaped, running down into the valleys, and, where they encountered no obstacle, reaching the sea. The coast Cordilleras acted as a barrier in the southern portion of the district; while in the northern part the liquors doubtless returned to the sea. The volcanoes which produced the upheaval exhaled immense quantities of carbonic-acid gas, by the action of which a portion of the sodium chloride in the mother-liquors was converted into sodium carbonate. The coast in this part of Chili is studded with small islands containing deposits of guano rich in ammonia. The guano-dust is carried by the prevailing west winds far into the country, where, on exposure to the air, at a warm temperature, it would gradually oxidize to nitrate, and, acting on the sodium carbonate, would form sodium nitrate, or Chili saltpeter.

Relics of the Chiriquians.—From the graves of the ancient inhabitants of Chiriqui, on the Isthmus of Darien, great numbers of relics in clay, stone, and metal have been obtained during the past thirty years. A collection of such objects, gathered mostly by Mr. J. A. McNeil, is now deposited in the National Museum. The Chiriquians seem to have been skilled in the working of metals. Gold, silver, copper, and tin—the latter in alloys with copper, forming bronze—are found in the graves. Gold is the most important, and is found associated with all the others in alloys or as a surface coating. The objects consist to a great extent of representations of life-forms, in many cases more fanciful than real, and often extremely grotesque. They include the human figure and a great variety of birds and beasts indigenous to the country, in styles resembling work of the same region in clay and stone. Gold, pure and in the usual alloys, was also used in the manufacture of other articles, such as bells, beads, disks, balls, rings, whistles, thimble-shaped objects, and amulets of varied shapes. Bells are more generally made of bronze, because, perhaps, of its greater degree of resonance. The great majority of

objects were formed by casting in molds. Hammering was but little practiced, excepting apparently in the formation of sheet-gold, which was probably an indigenous product. Repoussé work is not found, save as represented in the crimping and indenting of gold-leaf. Engraving and carving were not practised. It may be deemed certain that gilding, or at least plating, was understood.

Fish-ponds.—The making and maintenance of fish-ponds is one of the arts in which man—at least until within a dozen years past—has not advanced. It was better and more extensively cultivated in antiquity and the middle ages than now. And there is still no better authority on the subject than Bishop Dubravius, of Olmutz, of the sixteenth century. He advised a regular draining of ponds, and cropping them with vegetables and grain in alternation with the fish. He would have three ponds, with a three years' rotation of vegetable crops, grown and breeding fish, and fry, so that the proprietor would always have a crop of vegetables growing in one pond, yearling fry in another pond, and breeders with the fish fattening for the market in the third. Captain Milton P. Pierce, of the American Carp Cultural Association, recommends draining the ponds every spring as early as the weather will permit, to promote the growth of aquatic vegetation, and another draining in October for the purpose of assorting the carp. He uses three ponds, all at the same time for fish, but does not advocate the rotation and planting system of Dubravius. Opinions differ as to the expediency of allowing trees to grow along the margins of fish-ponds. They harbor insects and so contribute to the supply of food, but their falling leaves are litter and make the water unpleasant. Frank Buckland recommended the hanging of a dead cat or rabbit over the pond, to be a nursery for "gentles"—plainly maggots—which would fall into the pond and afford excellent food for the fish. The presence of ducks is of great advantage, for they dig up the mud in the bottom, exposing the organic life it contains, and also increase the insect-breeding capacity of the mud—all helping to furnish the fishes' dinner-tables. A similar effect follows allowing cattle to come and stand in the ponds. The ponds should not be too deep, and large ponds have several drawbacks which are absent from small ones. There are advantages and disadvantages about having a stream run through the pond; hence it may be well to arrange so that the stream can be turned on or carried around at will. A "collector"—a wooden box, four feet deep by five square, sunk flush with the pond, with a perforated inner box that can be drawn up—is a convenient appendage. When the pond sluice is opened, the fish will go into the deepest water, which is in this collector, whence they can be drawn out and sorted. The collectors also may supply the place of the deep retiring holes which fish are fond of resorting to. Some breeders furnish a hedge in the pond as a shelter. A fattening tank affords a convenient means of securing a constant supply of fish ready for the table and easy to be caught. To supply food for the fish, Herr Fruwirth, of Austria, has pools and ditches with stagnant water and aquatic plants, wherein all kinds of insects etc., breed, which he turns into the ponds from time to time. Dr. Kelsen, of Oxford, has discovered that the animalculæ bred in water containing decayed vegetable matter are eagerly devoured by the young fry. Captain Milton Pierce says that nursery ponds in good condition and provision will support from one thousand to fifteen hundred yearling carp per acre area of water. Stock ponds, in like condition, will support five hundred two-year-old carp per acre. Larger stocks should not be permitted. Only one kind of fish should be allowed in the pond at a time. Where there are many varieties, they come to little good, and eat one another up.

Watering the Floors as a Preventive of Coal-Mine Explosions.—Mr. W. Galloway, believing that coal-dust is a very active cause of mine explosions, and usually even a more important factor than gas, recommends watering or simply dampening the floors of mines as an efficient preventive of them. In support of his theory he cites the case of the explosion of the Pochin colliery, in November, 1884, where the flame, which had been very powerful, was found to have been arrested by a slight dampness—such only as was caused by the casual leakage

from a water-cask hauled over the spot four times a day—on one of the roadways. Systematic watering of one of the collieries in the Rhondda Valley has not only made it safer and cleaner, but also cooler and more pleasant to live in. The influence of watering the floor seems also to extend to the timbers and walls of the mine, which cease to give annoyance from the dust lying upon them, without being directly watered. When simple tanks on wheels are difficult or expensive to manipulate in the mines, they may be replaced by a system of pipes bringing water from the surface, or from a reservoir at a convenient height in the shaft, and distributing it at different points in the workings, in the form of a fine spray.

The Botocudos.—The Botocudos of Brazil are famed as one of the most savage tribes on the American continent. Mr. W. J. Steains, who met a number of them during his exploration of the Rio Dôce, describes them as hardly prepossessing in appearance, five feet four inches in average height, having broad chests—which accounts for the facility with which they can bend their bows—small rather than delicate feet and hands, lean but muscular legs and arms, and features bearing "a wonderful resemblance to the Chinese," with skins of all shades of color. The custom of wearing large lip and ear ornaments of wood is fast dying out. "A regular process has to be gone through before a Botocudo can boast of wearing a lip-ornament, say three inches in diameter, and what is more, it is a life-long process. When the Indian is about three or four years old its parents pierce a small hole in the center of its under lip and also in the lobes of its ears. Into this hole a small plug of wood is inserted about the size round of a pencil. In the course of a few weeks a larger piece of wood is made to take the place of the first insertion, and so on until the lip (having been thus stretched gradually) is capable of receiving a *botoque* (plug) of the dimensions mentioned above, viz., three inches in diameter. It generally happens that in course of time the lip, which stretches round the botoque just like an elastic band, splits. This action on the part of the lip, however, does not prevent the further wearing of the botoque. The Indian simply ties the two ends of his broken lip together by means of a small piece of imbira, or stringy bark, and thus mends the breakage in a way that is decidedly more useful than ornamental." The Botocudos live upon the nuts of two or three varieties of palm-trees, which, as they are hard, are chewed for old people and children by the women; and they usually live to a good old age. The men spend their days in hunting, fishing, and seeing to their bows and arrows, while the women look after the children, gather nuts and fruits, and do the hard work. Clothing is entirely unknown among them. Plurality of wives is allowed but not usually indulged in. The people have no form of government except that of a chief who has no real authority. They believe in a Great Spirit who has made the world, but offer no prayers or sacrifices. They think he is angry and are much frightened when there is a thunder-storm, and throw fire-brands into the air to appease his wrath. When a man dies, his ghost wanders about upon the earth, in pursuit of what he may catch, but benefiting those who have done him kindness while he was on the earth. They have a hazy idea of the evil one, and believe that he resides in the body of a certain screeching night-bird.

Life in the Islands of Greece.—According to Mr. J. Theodore Bent, who has visited them, the shepherds and their families of the Greek island of Karpathos "for the greater part of the year dwell in caves high up in the mountains and die in them like their goats, with this difference only, that their friends do not allow their bones to bleach in the sun, though they inter them without any religious ceremony; they wail over them a great deal, and wait for the religious part of the business until a priest chances to pass that way. For the three months of winter they reside in the village, which is composed of small homesteads or *mandras*, probably like that in which the herd of Ulysses dwelt in Ithaca. Each house is a low cabin, to enter which you have to stoop, and consists of one room only, where cattle and people live together. It is built of large stones without cement, and through the cracks the north wind whistles horribly. Across the roof is a beam the top of which serves as the cupboard. There is a place for fire, but no out-

let for smoke; some brushwood laid on stones is the family bed, and the floor in wet weather is inches deep in slush and filth. The summer spent in the caves and in the open air must be a delightful change from this. Sometimes you may see a serpent in these cottages, which is never disturbed, but is deemed the *genius loci*, just as in ancient days if a serpent was found in a house an altar was erected to it, and it was esteemed a symbol of happiness; and there are invisible serpents, too, they say, which bring good when blessed, but when driven away by neglect cause the destruction of homes; and thus they account for the Greek ruins in their midst. They look upon the green lizards which run over their walls with a very different eye. The idea prevails that it is from eating these that serpents derive their venom; so they kill lizards whenever they can, and it is thought that whoever succeeds in killing forty of them is sure to go to heaven, having saved so many men from poison. I visited many families in their mountain caves, which are deliciously cool in the summer heats, and the mud floors are scarcely ever dry. Stone benches are put along the sides covered with dairy produce; in one corner is the oven, where the new milk is simmering all day. When the family goes out to attend the flocks, a lot of prickly brushwood is placed at the cave's mouth; no other door is needed."

The Occidental Ant.—As described by J. D. McLaren, in the "Bulletin" of the Washburn College Laboratory of Natural History, the nests of the Occidental ant (*Pogonomyrmex occidentalis*, or Western bearded ant), seen from the outside, are bare, flat disks of earth, from three to six feet in diameter, with their center marked by a heap of pebbles, lime-nodules, sticks, and lumps of dried clay. The insects — who work in the evening, but not in the hottest part of the day or during storms—cut down all plants that spring up on the disk, carry seeds into the nest from the vicinity, and form, with the pellets of clay which they bring up from underground, and other solid lumps, a very hard and compact concrete pavement, which acts as a roof for the nest and sheds the rain. Some loose earth and a heap of sticks and pebbles are left around the holes, which serve as doors to the nest. During rain-storms this loose earth is easily pulled into the holes, so as to close them and keep out the rain. Digging into the nest, one finds a series of galleries, each from one to three inches below the other. In these galleries are some small piles of grass or weed seeds, with here and there a group of yellowish-white larvæ. The ants have a large, broad head, a small chest with two horn-like points projecting backward, and a small abdomen, and are, as a rule, chestnut-brown. They appear to be strict vegetarians. The small black ants build nests on the disks, and work among the Occidental ants in the greatest apparent harmony.

NOTES.

A PROPOSITION is on foot for forming vast reservoirs in the Rocky Mountains by erecting dams in the cañons to hold back the spring floods and store the water for use in the dry season in irrigating the arid lands of the plains. It is a similar scheme to that which was broached more than forty years ago to be applied to the ravines in the Alleghanies, for the purpose of furnishing the Ohio River with a constant supply. Major Powell, who is thoroughly acquainted with the region affected, considers the scheme entirely feasible, and believes that the expense, great as it will be, will amount to but a fraction of the value of the land that will be reclaimed. An appropriation of $250,000 for preliminary surveys is to be asked for.

THE Canadian Institute has sent out circulars inviting co-operation in an effort to collect data respecting the political and social institutions, the customs, ceremonies, beliefs, pursuits, modes of living, habits, exchange, and the devolution of property and office which obtain among the Indian peoples of the Dominion. As in the United States, there is danger of the opportunity of collecting and testing the facts relating to these traits soon passing away. Contributions to the philology of the Indian tongues and additions to their folk- or myth-lore will also be welcomed as heretofore. The schedule of inquiries embraces sixteen classes of facts, under which a considerably more minute amplification in detail is suggested.

A MARBLE medallion portrait of Dr. Thomas Davidson, the distinguished paleontologist, has been unveiled in the Geological room of the Free Town Museum in Brighton, England. Sir Richard Owen, who was not able to attend, sent a letter of regret, and Professor Judd wrote testifying to the skill and enthusiasm with which Dr. Davidson carried on his researches.

A TRIAL race was recently had at Tours, France, to determine the relative speed of different kinds of couriers. Four horsemen of the dragoons and hussars, four cyclists on cycles of different kinds, two trained dogs, and some carrier-pigeons, competed. The course was from Tours to Montbazon, 4,300 metres. The pigeons accomplished it in 5′ 35″; the hussars in 7′ 57″; the dragoons in 8′; the dog Brisefer in 8′ 8″, Turco in 8′ 38″; the bicyclettist (riding a velocipede with two small and equal wheels) in 7′ 5″; the bicyclist in 9′ 15; and two tricyclists in 10′ 30″ and 10′ 40″ respectively.

MRS. EMMA W. HAYDEN has given to the Academy of Natural Sciences of Philadelphia in trust the sum of $25,000, to be known as the Hayden Memorial Fund, in memory of her husband, the late Prof. F. V. Hayden. The interest of the fund is to be applied to the purchase of a bronze medal and a further money reward to be given for the best publication, exploration, discovery, or research in geology or paleontology. The determination of the award will rest with a committee suitably appointed by the Academy. The competition will be open to Americans and others.

ACCORDING to the calculations of Prof. Kirchhoff, of Halle, the Chinese language is spoken by 400,000,000 persons; Hindustani and English by 100,000,000 each; Russian by 70,000,000; German by more than 57,000,000; and Spanish by 47,000,000. French is seventh in order.

RABIES prevailed among the deer of Richmond Park, London, and made necessary the destruction of many of the animals. The character of the disease was determined by inoculating rabbits with it, and these animals died exhibiting the characteristic symptoms of rabies. The infected animals are transformed to fierce and savage beasts, almost rivaling the rabid horse in their attempts to do mischief. The disease begins with signs of mental hallucination, and develops, through aggressive rage, into paralysis, ending with death by failure of the heart. The macroscopic and microscopic appearances of the affected tissues reveal the usual lesions which are symptomatic of rabies, and thus determine the exact character of the disease.

The "rabbit-pest" in Australia is marching steadily onward to the north—not in search of new pastures, but, according to Mr. C. G. N. Lockhart, in answer to one of the animal's instincts. The buck-rabbit is disposed to kill all the young ones if he can get at them, and the does are aware of this propensity. Hence the does, when they find themselves pregnant, slip away from the males, and go on in the direction in which they have been advancing, which topographical incidents have determined shall be northwardly.

THE firemen of London are to be dressed in fire-proof clothing of asbestus, after a fashion that has already been applied in Paris.

WHY is it, as a succession of rain-gauges set up at the same place will show, that the quantity of rain falling on a given surface diminishes with the height? The explanation is suggested by W. Mattieu Williams that the temperature of the upper strata of the air being below that of the lower strata, the rain-drops gather moisture as they descend, and become much larger when they reach the surface than they were at any previous height above it.

Seal-skins, when worn by the seals themselves, are very different in appearance from those which have been fabricated into ladies' cloaks. The fur is not visible, but is concealed by a coat of stiff overhair, dull, gray-brown, and grizzled. This overhair has to be removed by a long, laborious process, and this work, according to the thoroughness with which it is done, largely determines the value of the skin. Skins from two to four years old weigh from five and a half pounds to twelve pounds. It takes three skins to make a lady's sack.

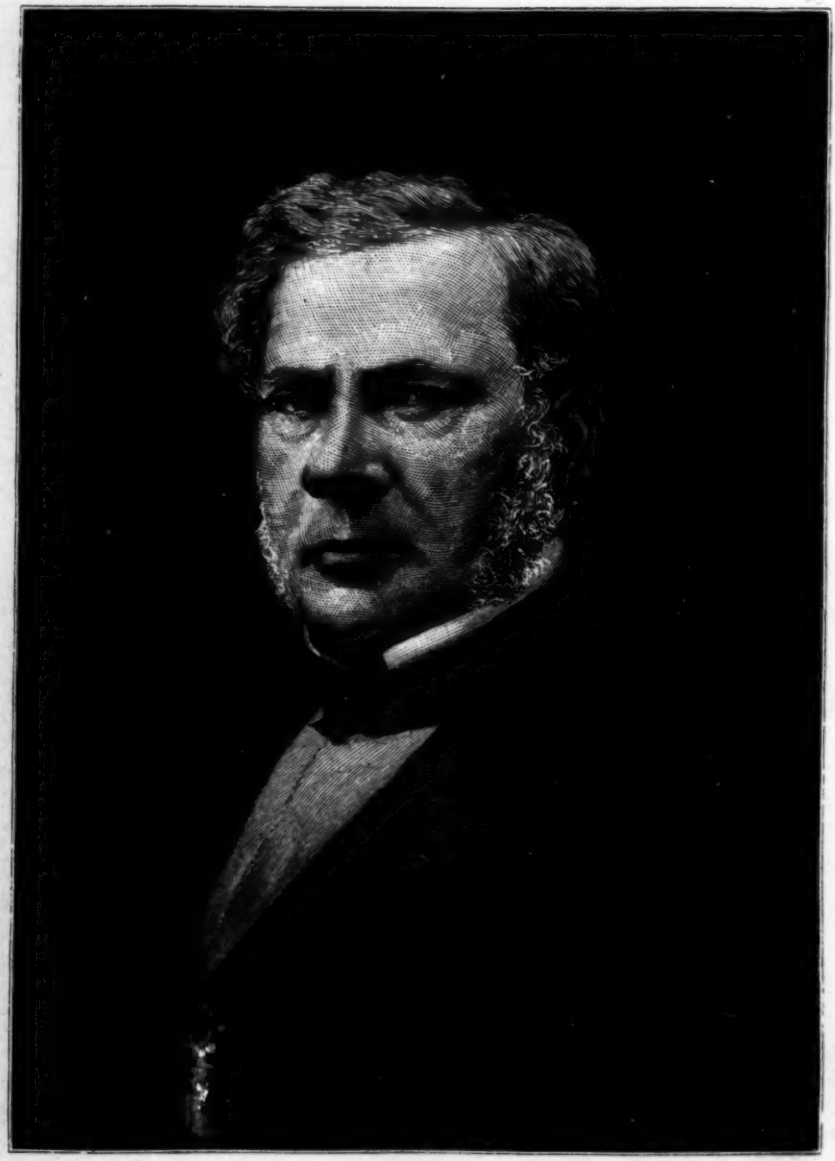
WHENCE, asks an English professor, came the men who inhabited the British Islands in preglacial times? Not from the east or south, for the remains of southern species of deer and other food-animals would have been found with theirs; whereas all such remains are of northern origin. Then, if men came down from the north, they must have gone up there in some previous age; and we have themes for curious speculations concerning the preglacial antiquity of man and polar climates.

The National Academy of Sciences has awarded the gold medal for an original investigation of meteoric bodies, provided for by the widow of Dr. Lawrence Smith, to Prof. H. A. Newton, of Yale University.

OBITUARY NOTES.

COLONEL JAMES STEVENSON, of the United States Geological Survey, and for many years connected with the Ethnological Department of the Smithsonian Institution at Washington, died in New York, July 26th, of heart disease. He was born in Maysville, Ky., in 1840.

HENRY CARVILL LEWIS, Professor of Geology at the Academy of Natural Sciences of Philadelphia, and in Haverford College, died in Manchester, England, July 22d. He had gone to Europe to remain three or four years in the prosecution of geological studies. It was among his immediate purposes to read a paper before the British Association, and afterward to visit Norway on a tour of geological observation.



JEAN BAPTISTE BOUSSINGAULT.